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Astronomical Photography.

Hints to Amateurs Regarding Apparatus and Methods of Working.

By ALEXANDER SMITH.

In dealing with astronomical photography from a practical standpoint, it may be explained at the outset that there is no single optical appliance suitable for all classes of work. Small nebulæ and dense stellar clusters require a telescope of sufficient focal length to give an image on a sufficiently large scale to exhibit structure, or to resolve crowded clusters into their individual components. For example, a focal length of eight feet is insufficient to resolve the central portion of such objects as M. 13, the great cluster in Hercules, while a similar instrument, when applied to some of the small but well defined nebulæ in the constellation Virgo, gives an impression on the plate no larger than that of a single bright star. The result to be aimed at in dealing with such bodies is to secure as large a photographic image as possible, which necessitates focal length, and, in order to bring the exposure within reasonable limits, a correspondingly large aperture.

The reflector with its single optical surface, absorbing as it does a minimum of light and giving at the same time the requisite correction for chemical rays, has so far proved the most popular form of photographic telescope in the hands of both amateur and professional, and the best all-round results have probably been obtained with specula having a ratio of aperture to focal length of f/4 or f/5. It has been found that with the sensitive plates now in use a reflector having an angular aperture of f/4 will record the faintest stars visible in the largest telescopes with an exposure of about 1 hour 30 minutes. If it is desired, however, to obtain impressions of large diffused nebulosities, such, for example, as that outside the Pleiades group discovered by Professor Barnard in December, 1893, on a plate, which had received an exposure of 10 hours, or of the large encircling nebula in the constellation of Orion, also successfully photographed by the same astronomer, then the ordinary telescope on account of its small field is altogether useless, and recourse must be had to a lens of short focus, which not only gives the requisite wider angle, but at the same time greater rapidity. Dr. Max Wolf has shown that his 2¼ in. aplanatic doublet is five times more effective for the delineation of nebulæ than the 13 in. Henry photographic refractor. On the other hand, it was found to be 32 times its inferior in recording impressions of stars ("KNOWLEDGE," December 2, 1895, p. 280). With such lenses—and those of the Petzval and stigmatic types are more particularly referred to—much original work may still be done, and, as they can be readily and effectively mounted on small clock-driven equatorials—either reflector or refractor—their use comes within the scope of amateurs, who may be already provided with such equipments. With a doublet lens of the portrait type, having an effective aperture of from 2 to 6 inches, and a focal length corresponding to an angular aperture of from f/3 to f/5, exquisite photographs of extended nebulosities, wide clusters, or of regions of the Milky Way can be readily obtained. Such lenses are also highly suitable for securing records of large comets, or of stray meteors, which may happen to cross the region covered by the plate at the time an exposure is taking place.

In selecting a lens for any particular kind of work it has to be kept in view that for photographing large faint nebulous masses the duration of exposure necessary to bring out a certain amount of detail is very appreciably shorter with a small lens than with a large one, notwithstanding that their angular apertures may be precisely similar. This is due to the circumstance of the smaller lens presenting a greater amount of contrast, and it is to this factor that the duration of exposure largely depends.

With points of light such as a star the duration of exposure is determined by the *intensity* of the rays, and, consequently, the contrast between the field and the stellar image depends entirely on the angular aperture of the lens, and the larger this is correspondingly fainter stars come within its grasp for exposures of similar duration. Of course, if the exposure is sufficiently prolonged, a small lens would record as faint stars as the largest telescope, provided the light rays are of sufficient intensity to set up chemical action on the plate.

Put briefly, the smallest class of lens, say, from 1½ to 3 inches of aperture, is the most effective optical appliance for the delineation of diffused nebulosities such as those in Taurus or Orion already referred to, while they are also well adapted for securing meteor trails. The class of phenomena coming within the reach of lenses of from 3 to 6 inches aperture is very much wider, and embraces well-defined nebulous areas, open clusters, regions of the Milky Way, stellar charts, comets, &c. If only a single lens is available it should have as large a linear aperture as possible, and as large an angular aperture as is consistent with good definition. For all solar, lunar, and planetary work, for crowded stellar clusters, for small nebulæ and all well-defined objects of this class showing structure, re-

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course must be had to the telescope, which, as already indicated, should for purely photographic purposes have an angular aperture of about f/4 or f/5. The size of the image on the plate will determine whether the focal length of the instrument shows the object on a sufficiently large scale to bring out the detail aimed at.

In presenting to the amateur the following hints regarding apparatus and methods of working, it ought to be pointed out that these are for the most part merely explanatory of the writer's own experiments, as he has never seen any photographic appliances used for astronomical purposes, other than those in his own possession. Satisfactory results can doubtless be obtained by other methods, and an ingenious amateur possessed of a little mechanical skill will be able to construct appliances in the shape of accessories, or adapt those he may have already at hand, to meet his individual requirements.

Mounting Cameras and Lenses.

To bring such lenses as those referred to into use they should be attached in the usual way to a suitable camera—preferably one of the old-fashioned box type, which secures the maximum amount of rigidity. If the lens is not fitted with rack and pinion the body of the camera should be made in two portions so that one part may be slipped, telescope fashion, into the other. When the solar focus of the lens has been determined previous to mounting a movement of about half an inch will be quite ample. The camera should be firmly bolted to the top of the telescope tube opposite the Declination axis, a position which least disturbs the balance of the instrument, and where any slight irregularities in the driving are reduced to a minimum.

With heavy lenses it is necessary that the mount be rigidly supported, otherwise the effect of flexure may, when the exposure extends to several hours, be apparent in the shapes of the star discs. A method which is found to be very satisfactory in practice is to place over the mount a flexible steel spring or strap tightly stretched by a screw to the camera base, which is extended below the lens for that purpose.

The circular caps, with which lenses are usually fitted when sent out by the makers, will be found with large apertures to be exceedingly awkward to manipulate in the dark, and are otherwise unsatisfactory. A simple arrangement, which leaves nothing to be desired, consists of a mahogany frame with shutter hinged to open like a door. If the hinges are placed at the side the shutter may be instantly closed with a piece of string, but, on the whole, it is, perhaps, preferable to have the hinges below, and the shutter to open from the top.

Fig. 1 shows a doublet lens of $5\frac{1}{4}$ inches aperture and 22 inches focus, mounted on a Newtonian reflector with the appliances referred to placed in position. It may be here incidentally pointed out that this is the only form of telescope which the writer has had in actual use in connection with photographic operations, and certain of the accessories described and methods of using such are only applicable to this type of instrument.

Having decided to give an exposure of, say, two or three hours, on a particular object, it will not infrequently happen in this changeable climate of ours that before the desired limit has been reached operations may be stopped by cloud, and provision must consequently be made for completing the exposure on one or more subsequent dates. The risk of disturbing the position of the objects on the plate is thus considerably increased, and one of the most frequent sources of trouble in this respect is due to replacing the shutter of the dark slide. This may be obviated by attaching a stout bar to the back of the camera, and if two screws provided with cushions at the ends are passed through this bar so as to press firmly against the dark slide, no

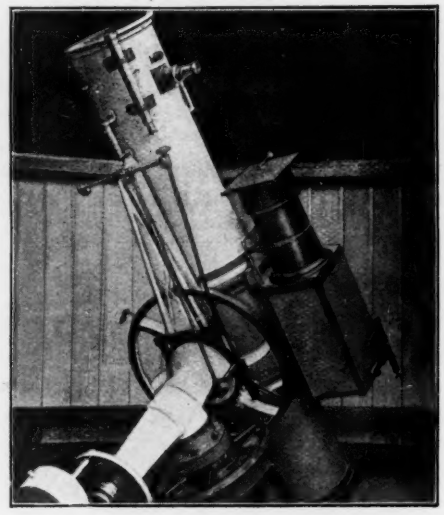

Fig. 1.

movement of the plate can take place. This arrangement is shown in Fig. 2.

Instances will occasionally arise where it is advantageous to have a number of short exposures of an object on the same plate. This is most easily done by moving the dark slide, and, in order to secure uniformity

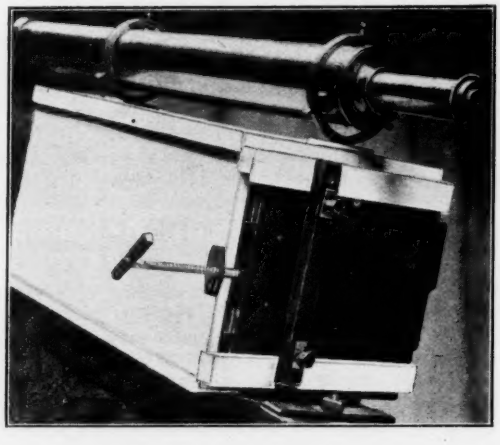

Fig. 2.

in making the necessary movement, a long screw (also shown in Fig. 2) may be attached to the side of the camera. The end of this screw presses against the slide, and by giving the requisite number of turns to suit the requirements of the object, a row of images is secured with exactly the same interval between each exposure. If a lens of long focus is used a very interesting series of photographs might be taken in this manner during the progress of a solar or lunar eclipse.

Guiding Telescopes.

In carrying on photographic work with lenses thus mounted the supporting telescope can always be used for guiding purposes, the best form of eye-piece being one of low power, fitted with cross wires sufficiently coarse to be readily seen on an out-of-focus image of a star. If the guiding telescope is of fairly large aperture, it will be found in practice that a star sufficiently bright can usually be found not very far from the centre of the field covered by the plate in the camera. The out-of-focus image of a faint star does not admit of being enlarged to the same extent as that of a bright one, and the cross wires should always be distinctly seen, otherwise guiding, particularly if the driving clock is not to be relied on, becomes a very tedious operation. The eye-piece should be turned until one of the cross wires exactly coincides with the path of a star across the field when the telescope is stationary, so that, apart from occasional slight alterations in Declination to correct for varying refraction, the movement of the telescope in Right Ascension will only have to be attended to, and any irregularity in the driving can be instantly corrected.

Focussing.

No difficulty need be experienced in adjusting the camera to the correct focus of the lens, if the sun be utilised for this purpose, and, when the position of the screen is such that the solar image is most sharply defined, this may for all practical purposes be accepted as the correct focus for all celestial objects. When the camera has been properly adjusted, and when this has been verified by a few exposures, the two portions of the box may be screwed together, as too much care cannot be exercised with the view of eliminating every possible source of movement which would be likely to disturb the register of the plate. If a screen of ground glass is used for focussing purposes it should be of the finest grade procurable. Perhaps a more suitable material is an ordinary gelatine plate, which has been exposed for a few seconds to a diffused light, and afterwards developed, fixed, and washed in the usual manner. Some have recommended a piece of plain glass with lines ruled upon it with a diamond.

Defining Properties of Lenses.

When the first exposure has been made a feeling of disappointment may be experienced when it is seen that the star discs are only sharply defined over a small central portion of the plate, while towards the edges they have the appearance of short circular trails. It must, however, be kept in view that the area of critical definition with even the best portrait lenses, when used without diaphragms, is usually smaller than the working aperture, and if a 5 in. lens covers a quarter plate sharply up to the edges, it may be regarded as having excellent defining qualities. With the view of getting good definition over a larger portion of the plate some have suggested a method known as "averaging the focus," *i.e.*, adjusting the focus to an object some distance from the centre of the screen. A few experiments carried out in this direction will, however, clearly show that the method is not one to be recommended, as it will then be found that the fainter stars at the centre of the plate, instead of being minute points, are blurred and enlarged. This applies with even greater force to photographs taken at the primary focus of a mirror, as the least alteration of the distance separating the speculum and plate appreciably alters the definition of the whole field.

(To be continued.)

Magnetism and the Corona.

Dr. Trowbridge's Experiments.

In the course of an investigation made by Dr. John Trowbridge, and reported by him in the *American Journal of Science*, on the phenomena presented by electric discharges in strong magnetic fields, he found that with high voltages and strong, steady currents, phenomena began to appear which were absent at lower voltages and lesser currents. For the purposes of the experiments, the description of which we are about to recapitulate, Dr. Trowbridge employed comparatively large tubes; and while the voltages ranged from 3,000 to 8,000 between the discharge terminals, the currents ranged from five milliampères to twenty milliampères. The cylindrical glass tubes containing rarefied air, which were used in the following experiments, were 30 centimetres long and four centimetres in diameter; and for resistances Dr. Trowbridge made use of a column of running tap water.

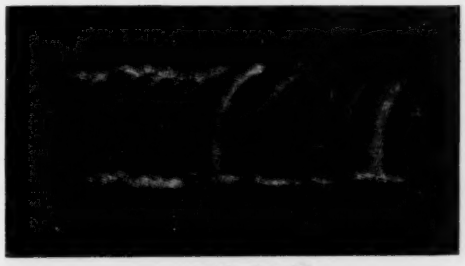

Fig. 1.

At pressures varying from 1 c.m. to 1 m.m., the cathode light on a circular aluminium plate, forming the pole of a powerful magnet, the magnetic lines of which were directed along the line of electric discharge, was driven to the circumference of the disc, forming to the eye an apparently steady circular discharge. When the tube was covered, however, with black paper, so that only the light on the disc could be seen, if this light were examined in a revolving mirror, an interesting case of unipolar rotation was seen. Fig. 1 is a photograph taken of the reflection in the revolving mirror.

The glass walls of the tube through which the photograph was taken and the necessary obliquity in the reflection caused by the mirror, modify the sharpness of the image. But the revolution of the image round the pole is apparent. The speed of revolution was found to increase with the degree of exhaustion of the rarefied air in the glass tube. Presumably when the free path of the ions increases, the progressive effect along the magnetic lines becomes more than the rotational effect of the magnetic field. When the plate formed the anode and also the end of a magnetic pole, so that the lines of magnetic force were directed along the line of electric discharge, the light at the anode was separated into two distinctly different lights, one (in rarefied air)

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a plume-like rosy light, the other a plume-like violet light. These discharges also revolved around the pole near the centre of the disc instead of on the circumference, as in the case of the cathode disc. On account of the number of individual discharges on the anode it was difficult to follow their motions in a revolving mirror, or by the eye, or to photograph them. It was certain, however, that they revolved about the pole.

Dr. Trowbridge draws the following inferences from the experiments :—

The unipolar rotation which I have described leads

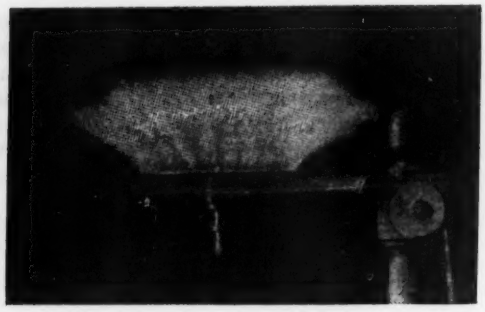

Fig. 2.

my mind to connect the phenomenon of coronal streamers seen at the poles of the sun in an eclipse with the effect of a magnetic field on possible electrical discharges between the equatorial regions of the sun and the poles of the sun. If we suppose that a difference of electrical potential can arise between the swiftly moving strata of gases or from the eruptions which take place mainly along the equatorial belt and the polar regions, the supposed magnetic poles of the sun would undoubtedly tend to cause the resulting electric discharges to revolve about the pole. On account of the

Fig. 3.

vast circumferential area about the poles a number of discharges could occur at different points around the pole and each discharge would revolve under the effect of the pole. In observing the effect of a strong magnetic pole on plate terminals in wide tubes of rarefied air, at comparatively high pressure of air under conditions of high electromotive force and great current density, one can observe phenomena of rotation which cannot be photographed yet which present to the eye a strong analogy to the appearance of coronal streamers.

I arranged a number of collections of bristles on a disc which was then set in rapid rotation. Fig. 2 is a photograph of the appearance of such revolving streamers, which represent fairly well what may be seen at the terminal of a discharge tube in a magnetic field.

There is, however, another magnetic phenomenon which may have a bearing upon the coronal streamers at the poles of the sun. When the lines of magnetic force are at right angles, or transverse to the direction of the electric discharge, at comparatively high pressures, one to two centimetres, with currents from 5 to 20 centimetres, 3,000 to 8,000 volts in wide tube streamers radiate from the position of the magnetic pole.

Fig. 3 is a photograph of such streamers or stratifications. "It will be noted," says Dr. Trowbridge, "That these striæ make their appearance at a much higher pressure than that of the usual striæ in rarefied gases." Similarly, electric discharges around or towards the poles of the sun, transverse to the lines of magnetic poles of the sun, could be separated into streamers.

Mice and Pneumonia.

OF late years it has been confidently asserted by the bacteriologists that the domestic cat is the harbourer and the propagator of the germ influenza. An equally serious accusation is being made against the domestic mouse, which is said to be a probable disseminator of pneumonia. The bacillus which usually is held to produce pneumonia is, in one form, that of the pneumococcus bacillus, very generally with us; and it has been sometimes assumed that the reason why it is a more successful enemy of the human race in the winter months—December, January, February, and March—is the smaller resistance which we offer to it in this season of reduced vitality. That is a fairly sound hypothesis. Sir Lauder Brunton has shown, for example, that fowls, which are normally immune from pneumonia, can be made susceptible if they are kept standing long enough in cold water. But Dr. E. Palier, in the *New York Medical Record*, has another suggestion to offer. The common bacillus of pneumonia, for which he proposes the name of "diplo-lanceo-bacilli-cocci," becomes virulent only, he maintains, when it has attained a new vitality by passing through the system of an animal extremely susceptible to it. Such an animal is found in the mouse, and especially in young mice, which are very readily susceptible, and to which the disease usually proves fatal. These mice, which are especially plentiful in the winter months, and are more noticeable in the insides of houses, take up the pneumococcus of human beings, absorb it, and restore it in augmented numbers and more virulent form. In poorly ventilated rooms the virulent "d.l.b.c.", as Dr. Palier shortly terms the characteristic bacillus emanating from infected mice or from their decomposing bodies, become abundant. Dr. Palier claims for his theory that it appears a plausible explanation of the duration of pneumonia. Virulent "d.l.b.c." do not lose their virulence at once, but after the third or fourth generation. When the virulent "d.l.b.c." enters the human body, some seven or nine days elapse before they are reduced to comparative harmlessness. It is possible that other animals besides mice may act as temporary hosts.

Eolithic Man.

By W. A. Dutt.

Just now, when the Eolithic controversy is generating so much heat, and we are having, to some extent, a repetition of the arguments used for and against the authenticity of Palæolithic implements some sixty years ago, it may be worth while to look a little further afield than the Kentish Chalk Plateau and see how widely eoliths appear to be distributed over the surface of the earth, and what are the views of the chief authorities on these supposed implements of human fashioning in respect to their relation to the question of the antiquity of man. That we are enabled to do this with slight difficulty we owe chiefly to M. A. Rutot, the Curator of the Brussels Royal Museum of Natural History, and one of the most diligent investigators of Eolithic problems.

As long ago as 1867, the Abbé Bourgeois claimed to have discovered at Thenay (Loir et Cher), at the base of some freshwater beds, which are now referred to the Upper Oligocene, some flints which had been worked by human hands; and if the human fashioning of these stones could be admitted they would furnish evidence of the earliest appearance of man on the earth which has yet been suggested to us. On the subject of these Thenay flints, however, authorities disagree, and as recent researches in the locality have failed to reveal flints bearing any resemblance to those found by the Abbé Bourgeois, M. Rutot considers it advisable to leave the matter of Upper Oligocene man in suspense.

About the flints of Puy-Courny, near Aurillac, however, he has no doubt, and in considering them the earliest genuine eoliths he has the support of M. G. de Mortillet, Dr. Capitan, and several German anthropologists. These Puy-Courny flints were first found by M. J. B. Rames, in an Upper Miocene deposit, and their chipping is said to be remarkably clean and characteristic. So far they are the strongest evidence of the existence of Miocene man. As M. Rutot remarks*: "This industry being the most ancient known and admitted, it is to the Upper Miocene we must go for the first certain evidence of the existence of man." During the last two or three years a great number of eoliths have been met with in various localities of the Cantal Miocene, and a fine collection of them has been arranged and classified by M. Rutot for the Brussels Museum.

Next in order of antiquity, M. Rutot places the flints of the Kentish Chalk Plateau, which he refers to the Middle Pliocene, and describes as implements intended to break, scrape, smooth, and pierce.

Coming down to the Upper Pliocene, he claims as representing the eolithic industries of that period the flints discovered by the Abbé Bourgeois at St. Prest and those met with by Mr. Lewis Abbott in the Cromer Forest Bed. Geologists are uncertain, however, whether the implementiferous gravels of St. Prest belong to the Tertiary or the Quaternary period, and there seems to be a general opinion that it is safer to refer them to a period of transition between two distinct epochs. This is also the case with the deposits of the Cromer Forest Bed. So far very few supposed worked flints have been found in the Forest Bed; but M. Rutot, to whom these were submitted by Mr. Lewis Abbott, states that he had no difficulty in recognising them as eoliths.

The earliest Quaternary deposits containing eoliths are, according to the same authority, met with in the valley of the Lys (Flanders), in the valleys of the Escaut, Haine, Sambre, and Meuse, and on the plateau of the Campine. These early Quaternary implements are especially abundant around the village of Reutel, and M. Rutot has given the name of Reutelien to this particular eolithic industry. "The use of the flints," he writes, "dates from the beginning of Quaternary time, corresponding with the phase of the advance of the first Quaternary glacier." With the retreat of this glacier a new industry was developed, examples of which are found in the valleys of the Dendre, Haine, Sambre, and elsewhere. This industry is considered to be transitional between the Reutelien and a later one called Mesvinien, after a characteristic locality situated between Hyon-Ciply and Spiennes. This last-named is also unmistakably eolithic; but in certain localities the beds containing it are overlaid by deposits supplying transitional forms between the eolithic and early Palæolithic. The second transitional industry, which is known as that of Strepy, is naturally reckoned by M. Rutot as one of great interest and importance, as the localities in which it is met with not only provide implements in which eolithic forms are perfected, but also types which enable the archæologist to understand the origin of the well-known almond-shaped implement of the Palæolithic period.

It may be mentioned in passing, that M. Rutot, after drawing attention to the fact that the primitive or eolithic period is characterised by an absolute stagnation—that is to say, the latest eolithic implements are no better nor worse fashioned than the earliest—advances an ingenious theory to explain the sudden advance in flint-working, noticeable in the period of transition between the Eolithic and the Palæolithic. This was due, he suggests, to a purely geological cause. In the Tertiary period, he says, an abundant supply of flints could be easily obtained by the men who had occasion to use them; but at the beginning of the Quaternary the flint beds were, to a large extent, covered by fluviatile deposits. As a result, men began to fight for the possession of the localities where flints could still be found, and this fighting led to the invention of implements which could be used as weapons of war.

In a paper printed in the Bulletin of the Brussels Anthropological Society, the distinguished Belgian savant expresses a belief that the investigation of eolithic problems now in progress must, in course of time, have valuable results, and he instances the discoveries of stone implements by Dr. G. Schweinfurth in Upper Pilocene deposits, in the neighbourhood of Thebes, and of similar implements by Dr. Klaatsch, in beds containing remains of the great marsupials (Diprotodon) of Queensland as evidence of the wide distribution of eoliths over the surface of the globe.

The accompanying photographs of flints of eolithic forms produced in the Cement Factory of Mantes must naturally arouse considerable doubt as to the human fashioning of many so-called eolithic implements; but it remains to be proved that natural causes can have effected such flaking and chipping as is done in a cement factory.

By the courtesy of the Secretary of the Anthropological Institute we are able to reproduce the photographs made by Dr. Hugo Obermaier, of Paris, of the flints of eolithic form which are accidentally produced in the process of making cement at Mantes, and Dr. Obermaier, in his paper, says:—"I know no eolithic type which has not its correlative at Mantes. Specimens of large size are only absent because the bigger blocks and slabs are not put into the machine; but there occur cores, flakes, scrapers, and borers—in a word all the eolithic types; and these are partly of rudimentary execution like the 'utilised' flints of the pre-palæo-

* Bulletin of the Belgian Society of Geology, Palæontology, and Hydrology, Vol. XVII. (pp. 425-438.)

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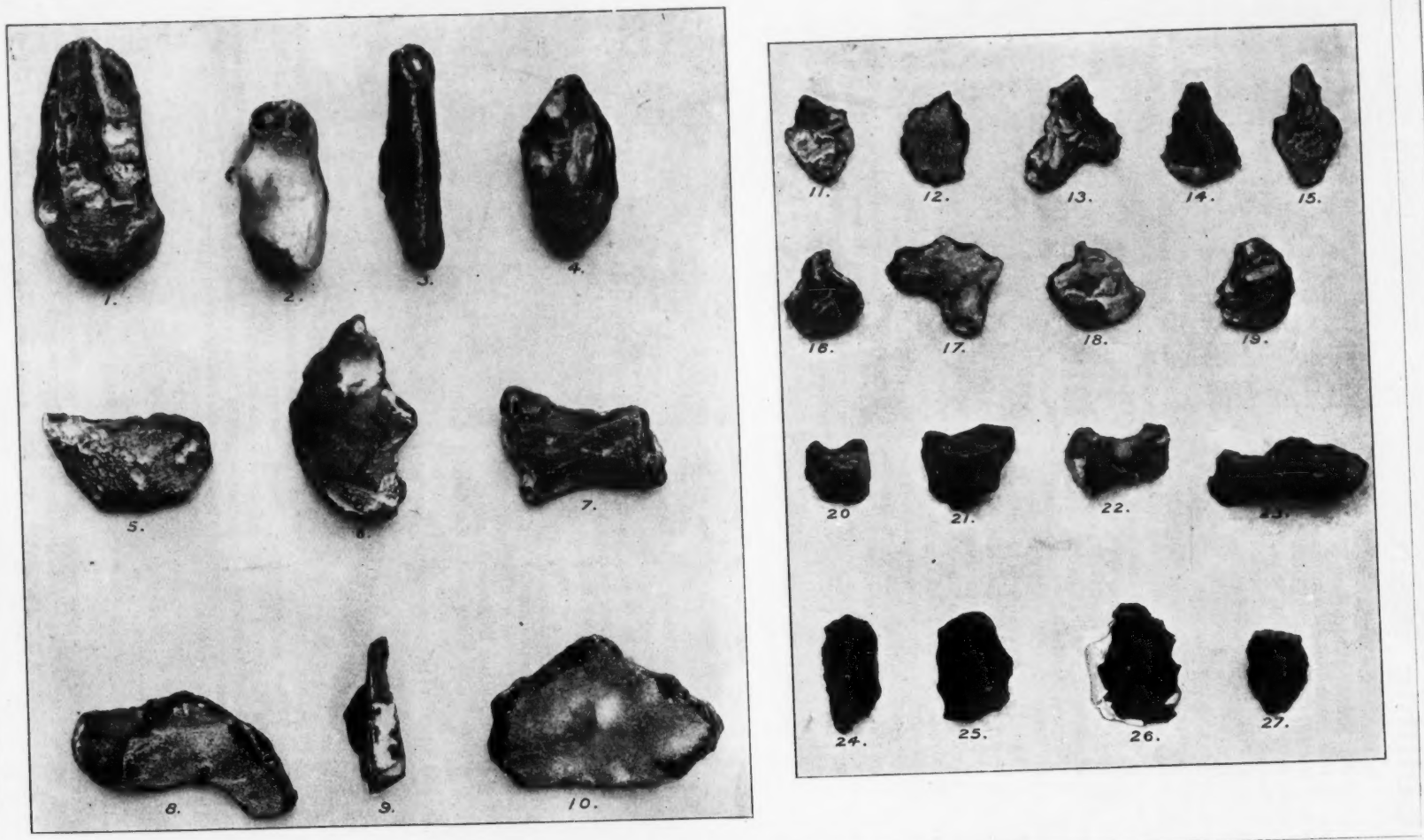


Flints of Eolithic Form Produced in the Cement Factory at Mantes.

Reproduced, by permission, from "Man," the Journal of the Anthropological Institute.

lithic stage, partly of very complete development. Even the remarkably perfect pieces which are occasionally found among eoliths have their parallels at Mantes, where there occur scrapers, hollow scrapers (*lames à encoches*), and borers, which recall the finished types of La Madeleine. Bulbs of percussion, secondary chipping, and the other so-called criteria of intentional workmanship are all represented in their turn; and this is the more remarkable because the flint of Mantes is dry and hard of fracture. Were the softer flint of Puy Courny, for example, placed in the machine, we might expect modifications which differ from those appearing in the more refractory material obtained from the chalk.

"The process of manufacturing eoliths at Mantes is a rapid one. Recent experiments have shown me that they can be produced after a few hours of the rotary motion in water. When the tub is emptied after the lapse of twenty-nine hours the condition of the flints suggests the following sequence of events. Those first affected assume eolithic forms and are subsequently rolled and worn; at a later stage some of them are subjected to further shocks which give them the appearance of re-worked implements; in this condition they would resemble later (re-worked) eoliths. In any case it is demonstrated that the cement tubs of Mantes produce eoliths which are astonishingly like those of geological formation. As I showed in my previous paper, the arrangement of the machine proves that the pseudo-eoliths are chipped, not by any part of the mechanism, but by the shock and pressure of one flint against another. The rapid action of the water resembles that of the Rhone, Rhine, and other rivers when in flood, while smaller streams would be still more impetuous. The pot-holes formed by rivers are known to every student of geology. Anyone who has ever studied the ancient gravels of the Seine or Somme and other rivers, will be readily convinced that their volume was once very different from that which we now see. To-day they can scarcely carry down pebbles of small size, but formerly they deposited strata of the coarsest gravel, containing rolled blocks exceeding a metre in diameter. All this presupposes a torrential river-action such as no longer exists in these regions at the present day, but was experimentally reproduced at Mantes."

Few people could readily say which of all animals was the most conservative, but an article by Dr. E. H. Sellard in the *Popular Science Monthly* enables us to award the palm to the cockroach. No insects are more abundant as fossils and none so widely distributed through the various formations as are the cockroaches. The domestic cockroach, as many of us are aware, has a predilection for the neighbourhood of the kitchen boiler. The reason for it is that throughout geological time it has delighted in moist places. They are often found near the traces of streams; usually embedded among the remains of fossil ferns; and, indeed, persistent search among fossil leaves of land origin will hardly ever fail to bring to light at least detached wings and perhaps bodies of prehistoric cockroaches. It is an approximately complete geological record, an almost undamaged genealogical tree, which lends an especial interest to the cockroach family. Throughout their long existence they have retained, as compared with other insects, a relatively generalised structure. Morphologically they have learnt nothing, and have forgotten nothing. There have been one or two changes in their structure since Palæozoic days. Their heads became flattened; the upper part of their chests, the first thoracic segment, became rounded in the carboniferous era. The wings also began to change in the time of the coal measures, and the modern cockroach shows an alteration of the wing dating from Permian days and developing since. But except that the adventurous spirit and probably the fighting ability of the early days, as marked by stronger wings and bigger bodies, have decayed, the cockroach to-day is about exactly what it always has been.

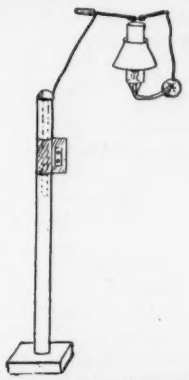
A Simple Gas-Lighter.

By Charles E. Benham.

The following simple device will be found very convenient for gas lighting, especially where incandescent mantles are used.

A celluloid tube—the tube of a cycle pump is exactly the thing, and at the cycle shops there are always worn out pumps to be had for a few pence—is fixed vertically in a wooden socket. At the upper end is inserted, so as to line the upper part of the tube, a wooden rod covered with tinfoil and about six inches in length. The rod is surmounted by a metal ball, which rests on the top of the celluloid tube. From the ball a thin wire is led to a thick iron wire projecting from the wall to a point centrally over the gas chimney. This iron wire must be insulated from the wall by a vulcanite or glass support. A second iron wire, uninsulated, also projects from the wall and terminates at a point about one-tenth of an inch from the first.

A strip of celluloid—such as a photographic celluloid film with the gelatine removed—clasps the celluloid tube by means of two little strips of wood, glued to it



A Simple Gas-Lighter.

as shown, and screwed together when the encircling film has been drawn tight round the tube. The film so forms a rubber which, when held by the wooden strips, can be passed up and down the celluloid tube. At every movement up and down of the rubber, sparks fly between the terminals, and the gas lights instantly. The finger and thumb should nip the rubber in the centre so that it presses close to the tube. The arrangement is not materially affected by atmospheric conditions. A curious feature of the device, and one which at first sight appears to be unorthodox, is the circumstance that the rubber and the electric to be excited are both of the same material, instead of being of different materials as is usually the case with friction machines. A rubber of flannel or silk may, however, be used instead of the celluloid film.

The mounted celluloid tube can be affixed either vertically on a shelf below the gas bracket or projecting horizontally from the wall, as may be the more convenient arrangement.

The terminals should not be pointed, but should be formed by loops at the ends of the thick wires, which are to be adjusted so that the spark is about an inch above the top of the gas chimney. The tube should preferably be of white celluloid. Using a larger celluloid tube a Geissler tube may be beautifully illuminated by connecting it with the brass ball.

XUM

The Coloration of Mammals and Birds.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S., M.B.O.U., &c.

(*Continued from page* 373.)

So far, our remarks have been restricted to those "poecilomeres" which were first to be noticed as "centres of bleaching" in Ratufa, but a closer examination will show that, in addition to those already mentioned, several other spots are to be noted.

Although in the present state of our knowledge we cannot show these to be actually "bleaching centres" in any particular species, yet they correspond so closely with those "poecilomeres" already mentioned that there can be no doubt that they arise in a similar manner.

The complete list of "poecilomeres" is, therefore, as follows:—

On the head, we have the nose, lips, chin, crown, occiput, ears, and the eye. This last has, in reality, two spots, the one in front of and above the eye (supra-orbital), and the other below and behind it (post-orbital). The white-eared cob (*Cobus maria*) gives us a good example of the eye spots.

On the upper part of the body we have the shoulders, thighs, rump, tip of the tail, wrists, and ankles.

The underparts are, as a rule, more uniform in colour, but where any tendency to diversity is shown we find it taking place along fixed lines, and the following spots may be noted as "poecilomeres, viz., the chin, inside of the arms and legs, fore-end of the sternum, and the vent or pubic regions. The best example of underside "poecilomeres" is to be found in a squirrel of South America (*S. dorsalis*), which is, as a rule, ochreous underneath, but shows in many individuals permanent white patches on most of the spots. In *S. pryeri*, a Chinese squirrel, the armpits and inside of the thighs and vent are rufous, while the rest of the underparts of the body are white.

Among birds the white ring of the ring ousel, the white breast of the female frigate bird, the red breast of the shell-duck, the violet patch of the jambu fruit pigeon, and the red patch of the blood-breasted pigeon, are good examples of the sternal "poecilomere." The red vent of the woodpecker and white vent of the moorhen are examples of another patch.

As regards the face markings among birds, the common kingfisher affords a good example, showing us the white chin patch, the green malar stripe, corresponding to the lower lip in mammals, the dark mandibular stripe, the rufous supraorbital and postorbital, and white oral patch. To continue multiplying instances of these spots is unnecessary. Anyone interested in the subject has only to go through any collection of birds or mammals to find instances on all sides.

It has been further pointed out to me, and is, perhaps, not without its significance, that the spots in which hair is found in man are all to be found among these "poecilomeres."

Unfortunately I am not a physiologist, nor have I been able to find in any book* facts which would tend to throw light on the nutrition or otherwise of these particular spots, but there is little doubt that any practical physiologist, who could afford the time, might, by investigations carried on in this direction, add a considerable amount to our knowledge of the cause of the patterns and markings in animals.

Most of the warning and protective markings will be found situated on these "poecilomeres," but there is one point which I would wish to impress, namely, that these same markings will be found in hundreds of cases, where, unless they were looked for, they would pass unnoticed, being merely represented by differences in shade so slight that they cannot possibly be said to serve any purposes of protection, warning, or recognition, but, in my opinion, form additional evidence to show that the brighter and more conspicuous markings have a much deeper significance than that put forward by those who believe the theory of natural selection to be all sufficient.

As examples of this, I will notice two or three from among our local British birds. In the hen house sparrow, for instance, the rump is unspotted; the rump of the hen chaffinch is slightly greener than the rest of the back; the hen yellow-hammer shows the dark ear patch and light malar stripe and chin. The linnet shows the two eye patches. The young cuckoo will often show a few white feathers on the occiput or crown. The wryneck (*Junx torquilla*) shows faintly the beginnings of the chin or malar stripe in having the feathers of those parts, although resembling the rest in pattern, white instead of yellow, while the dark patch in front of the barn owl's eye and the yellowish tinge on the breast are further evidence that the smallest of these markings is no mere sport or accident, but the result of deep-seated physiological causes. Among our British mammals the white spot on the forehead sometimes found in the common hare may also be accounted for on the same lines of reasoning.

"Poecilomeres" also manifest themselves in some species in a transitory state. The stoat offers a good example, for when it commences to assume its white winter dress it does so along well-defined lines. The first spots to show white are the thighs, whence the white spreads down the hind limbs and along the sides, gradually encroaching more and more on the colour of the back. It then appears on the rump and shoulders, spreading down the tail from the former, and down the forelimbs and over the shoulders from the latter. The head remains coloured to the last, but when it begins to change, the lips, nose, and ears are the first to whiten, the white from the nose extending up between the eyes as far as the forehead, thus leaving the eyes, postorbital patch, and frontal patch the last to turn. In a lesser degree this may be observed in many mammals; the common hare, for instance, showing a tendency to lighten on the thighs on the approach of winter.

Among birds the following example has come under my notice recently, and, with further observation, doubtless instances might be indefinitely multiplied. During the past winter I have had under observation two young shovellers (*Spatula clypeata*) that, during the early months of the year, have been slowly assuming the metallic-coloured head of the adult. Both birds performed this process in the same manner. The first sign of the metallic plumage was observed on the postorbital and ear patches simultaneously; these two patches spread and joined together forming a metallic patch similar in range and definition to that found permanently in the male teal. The patch of

* I am not unmindful of Captain Barrett-Hamilton's paper (already referred to) where he is inclined to consider the white patches to be due either to the presence of subcutaneous fat or to the direct contact of bone with skin, but for the present I prefer to express no definite opinion on this point. Mr. Tylor has also some suggestive ideas on this point.

adult colour then spread across the head till the whole of the head with the exception of a patch across the front was deeply coloured, the bird now having its head marked similarly to the hen scaup (*Fuligula marila*). The final stage was completed by the colour spreading *backwards* from the beak to join the metallic colours that already existed.

This case is important for several reasons. Firstly from its analogy with the case of the stoat, where, although the reverse change was in process, yet the parts that in the shoveller were the first to become coloured were in the stoat the last to become white *

Secondly, to find processes, whose *outward* effects are so transitory that they can be of no importance to the individual, practically identical in two animals as widely separated as a carnivorous mammal and an aquatic bird can only point to one conclusion, viz., that they must have some deep meaning in the internal economy of mammals and birds far transcending their external effect.

Another point to be noticed is that during the change the birds assumed the more or less characteristic markings of two other species of duck, thus hinting at the probable way in which such markings arose, and, lastly, the assumption of colour on the lines of the "poecilomeres," beginning with the postorbital and ear, and these two joining together and subsequently covering the crown and occiput, while, finally, instead of the colour gradually spreading forwards it started again from near the beak, that is to say on the lip and nose "poecilomeres," whence it covered the head, this, I think, shows that these "poecilomeres" have very real and definite areas, and that although the colour arising from one "poecilomere" may spread into an area usually fed, so to speak, from another one, yet these "poecilomeres" will always be the first or last patches to be affected.

It may perhaps be said that the above example is a solitary instance and mere coincidence, but this is not so. The hen tufted duck yearly assumes for a short time during the summer the white patch characteristic of the scaup.

The blackheaded gull assumes during the early months of the year the brown hood in a very similar manner. The two eye and ear patches show first; these at first tend to join across the head with the crown and occipital patches, forming two dark transverse crescents until, finally, the back of the head becomes brown, leaving the frontal patch the last to become coloured. A herring gull, when assuming the white head of summer, becomes white round the beak first of all, and when in the brown plumage of immaturity will first show signs of the white breast on the sternal patch. The black throat of the lapwing (*Vanellus*), worn in summer, first appears on the chin immediately behind the lower mandible, and gradually spreads over the neck until it joins the black collar, and in many cases in young birds, *e.g.*, the corncrake (*Crex*), the feathers composing the ear patch are the first to grow.

Lastly I have known a brambling (*F. montifringilla*) that, in assuming its black head by abrasion of the feather tips, first lost the brown tips of those feathers round the beak that formed the frontal patch before referred to. This forms additional evidence that abrasion takes place on lines similar to those controlling "bleaching," and that it is a process governed by internal conditions.

This paper deals with a subject of such vast proportions and is dependent on so many minute details that it may be well to sum up the results and arguments in a concise form.

SUMMARY.

The object of this paper has been to show, firstly, that the colour of a bird or mammal is primarily due to "activity of nutrition and function," which has been called "vigour," and that where conditions for a high state of "vigour" exist we shall find the majority of animals brightly coloured and *vice versâ*.

"Vigour" is dependent on two causes.

(1.) Climate, which contains two factors:—
  (*a.*) Temperature.
  (*b.*) Food.

(2.) Rise and fall of sexual activity.

In *Polar Regions*, where the two causes coincide closely, the changes are much more marked and violent.

In *Temperate Regions*, where the climate is sufficiently severe to affect the "vigour," but where, at the same time, there is a sufficiently long period of comparative plenty to prevent the sexual activity clashing with climate, the changes are less marked.

In *Tropical Regions* the first cause is practically removed, and any changes in colour are due to sexual causes, except in cases of temperate species which have spread into the south.

Now the individual "vigour" of various species and groups will differ, and one animal may be able to maintain a full vigour under conditions which would be impossible to another. This will account for animals, although Polar, becoming brightly coloured, *e.g.*, musk ox, raven, penguin, &c. It follows, therefore, that if they can maintain a full "vigour" in colder regions, they can either (1) maintain an equally full vigour in the tropics, or (2) in hotter climates their metabolism would become too active and they would die. Consequently, a dark-coloured animal, in Polar regions, must either be confined to Polar regions or be cosmopolitan, *e.g.*, musk ox, raven.

By a similar process of reasoning, bright-coloured tropical animals will be found extending northwards, probably becoming lighter, while white or light coloured tropical animals will be confined to the tropics, *e.g.*, tiger, and *Rhizomys sumatrensis*, the bamboo rat.

Seasonal change or migration is a necessity in Polar regions, and birds which migrate to the tropics assume much more gaudy colours while in hot climates, becoming dull when the moult takes place in the Arctic regions, *e.g.*, knot (*Tringa*).

In temperate regions seasonal change will be a constant feature, but the changes will not be so marked, *e.g.*, squirrel, deer, but when these animals reach torrid zones, the "seasonal change" will tend to persist for some time, gradually disappearing, or it may become a "breeding change," as *Sciurus caniceps*, *Cervus eldi*.

There is among mammals and birds a process known as "bleaching"; this, I attempt to show, is an *active* process, and not mere action of wind and weather.

I further show that *bleaching* always takes place along certain lines, starting and spreading in various degrees from certain centres, *e.g.*, lips, eyes, ears, crown of the head, occiput, shoulders, thighs, fore end of the sternum, vent, tip of tail. To these centres or spots the name "Poecilomeres" (spotted part) is given.

The second part of the paper is devoted to showing how these "poecilomeres" exist as either white or

* I am now able to add a third precisely similar method of change in the assumption of the eclipse plumage in a smew (see *Avicult Mag.*, Feb., 1905.)

deeply-coloured patches throughout the majority of species of mammals and birds, sometimes as large and conspicuous patches, *e.g.*, hindquarters of the rabbit, rump of bullfinch, and at other times only distinguished from the surrounding parts by differences of shade so slight as to be incapable of serving any warning, protective, or other similar purpose.

It is then pointed out that in some cases the "poecilomeres" are only visible as transitory patches during the time an animal is undergoing a change of colour.

The head of the stoat and of a young shoveller drake are cited amongst others as examples of the change taking place along precisely similar lines, whence it is argued that as the outward effect is so slight and transitory, and as the process exists in two animals so widely separated, the fundamental cause must be a deep-seated physiological one.

We, therefore, claim to have shown that where conditions for high vigour exist the majority of the animals will be brightly coloured, and suggestions are made to account for the apparent exceptions to the rule, which suggestions are borne out by the distribution of the dark Polar and light tropical species.

We have also shown that shortly before a moult, in many animals, the colour of the pelage fades, beginning along certain definite areas, and from certain centres which I have called "poecilomeres," and that this bleaching is due to physiological causes.

Further, that "poecilomeres" may be found throughout the mammalian and avian series, as patches differing either in their intensity or lack of colour from the surrounding portions, in many cases conspicuous, and cited as examples of warning, protection, &c., or, again, as marks so slight as to be unnoticeable unless carefully looked for, or yet again, merely appearing as transitory patches during the growth of a new pelage or plumage. Hence it is argued that these patches, so universal, and in many cases so inconspicuous, must owe their inception to internal rather than external causes, and that we have here the basis of diversity of colour in coloration. If these facts then be accepted, both colour and coloration must be due to physiological causes.

The question of whether seasonal changes are produced by moult or by colour has purposely been entirely omitted as belonging to a side issue.

Natural selection and protective coloration have also been left out, not because we do not believe in the great part they play, but because, if our suggestion be near the truth, they are only able to make use of those colours or modify those markings which in the first place are supplied by "vigour."

Tuition by Correspondence.

THE University Examination Postal Institution of 27, Southampton Street, Strand, publishes a series of handbooks which are specially and excellently adapted for Cambridge Higher Local Candidates. The series includes a guide to this examination, giving full details as to method of preparation, and advice as to text books, together with reprints of papers set at previous examinations. As each paper is printed on a separate perforated sheet, it can be used by schools for examination purposes. The papers are kept up-to-date by the insertion once a year of the latest papers. To the French and arithmetic papers full answers by F. Thomas, B.A., B.Sc., and W. H. Dines, B.A., F.R.S., are published in addition to the questions. Both the method and the subject matter of this valuable little series of handbooks are well arranged, and we can confidently recommend them to the perusal of candidates and students.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Uncorrected Lenses.—A week or two ago, the Photo-Club, of Paris, opened, in their rooms, an exhibition of photographs made by means of lenses uncorrected or only partially corrected for chromatic aberration, and it appears that in due time a collection of these prints will be shown in London by the Royal Photographic Society. Uncorrected lenses have been used, and used purposely on account of the character of the image that they give, for long enough, but the lenses that this collection illustrates the use of, have been recently designed by MM. L. de Pulligny, and C. Puyo, and are issued commercially by L. Turillon, of Paris, under the name of "Anachromatic" lenses. They may be employed in the form of single lenses, symmetrical doublets, or with a negative lens behind a positive, as in telephotographic combinations. So far as can be gathered, it appears that the effects of chromatic aberration are specifically valued, as giving what a perfect lens would render as a sharp line, in the form of a diffused line that is darkest down its centre and gradually becomes lighter as the distance from the core increases. In this way, detail is softened and fine detail is averaged down to a comparatively level tone. These desiderata will be appreciated by many artists who photograph only for the purpose of making "pictures."

Of course, such lenses must be of greater focal length for a given plate than the modern anastigmat or even its predecessors need to be, because of their inferior covering power. The aim of the optician is to improve definition and increase covering power, and quite rightly so, but if the pictorial worker does not want these improvements, he is a positive loser in having instruments that possess them. It is the photographer's ignorance of optical matters that leads him to imagine that the more costly a lens, the better it should serve his purpose. Whether it will do so or not depends entirely on what his purpose is, and wherein the special value of the lens consists. The greater focal length is generally a distinct advantage in pictorial work, and granting this, the need for costly lens systems does not exist, even when fully corrected lenses are required. Complete descriptions of the "Anachromatic" lenses are not to hand, and therefore the novelty of their construction, if they are in any way novel, cannot be now given.

Improvements in "Cooke" Lenses.—Mr. H. Dennis Taylor, of York, the inventor of the "Cooke" lenses that are so well-known to photographers, is still seeking to improve them and increase their usefulness. The three single lenses that constitute the ordinary Cooke objective cannot be separated into two complete parts of greater focal length like so many modern lenses that thus give in one instrument the choice of two, or, if not symmetrical, three focal lengths. Mr. Taylor has devised a means of obtaining this advantage by duplicating the usual system of three lenses, making

such modifications as the new arrangement requires. The diaphragm has, of course, to be between the two systems, and to maintain the aperture for oblique rays the exterior lenses are slightly enlarged and brought nearer to the others. In such a complete objective the light has to pass through twelve surfaces of glass in contact with air. And in a modification described, in which there are eight separate lenses, there are sixteen such surfaces. At every surface of glass to air there is a loss of light due to reflection, and Mr. Taylor estimates this at about forty-eight per cent. of the incident light, when there are twelve glass surfaces. A part of this light is altogether lost, passing out of the lens in front, but a part goes in the other direction and contributes to the general useless light in the camera, which of course, tends to produce fog on the plate. Mr. Taylor seeks to remedy this defect and secure greater brilliancy of image, by tarnishing the polished surfaces of the lenses, using a solution of sulphuretted hydrogen, for example, until they assume a brownish-slate colour by reflection. He thus claims to get a rather more brilliant image with six or even eight lenses than with only three lenses normally polished. It is quite easy to understand how that such a procedure will reduce the amount of reflected light, but it is not so easy to see how it increases the image-forming transmitted light. It appears at first sight that the tarnishing will reduce both the reflected and the transmitted light because of its absorbing power, but Mr. Dennis Taylor is such an experienced and expert technical optician that, presumably, there is some fault in this simple view of the matter. It may be noted that these improvements in Cooke lenses are not yet practically available.

Clearing Intensified Negatives.—The character of the gradation of a negative is, or ought to be, one of its most valuable properties, and, as I have often said before, there is only one method of intensification that has been shown to preserve it, namely, the mercury and ferrous oxalate method. All the more usual processes and a great number of those suggested but rarely used, have been definitely shown to be uncertain and unproportional in their effects, and therefore to alter the gradation in uncontrollable ways. A minor drawback to the use of an oxalate when only hard water is available is the precipitation of calcium oxalate, some of which may attach itself to the surface of the gelatine. If kept clean, it disappears entirely on varnishing and is quite inert, but it may, if desired, be removed by merely placing the negative in weak hydrochloric acid until it has been dissolved away. The strength of the acid seems to matter very little; perhaps strong acid. with ten times its bulk of water, is a good average. The time required may vary up to a few minutes. I have seen celluloid films and plates of various kinds treated in this way with invariable success, and have not heard of any failure or accident. The risk of frilling seems to be practically negligible. Therefore there are three distinct ways of obviating the difficulty resulting from such a deposit:—(1.)—It may be prevented by the use of soft water before and after the application of the oxalate. (2.)—It may be removed by means of hydrochloric acid. (3.)—It may be neglected if the negative is to be varnished.

E. A. Wilson.—We do not know of any more recent book on the determination of longitude by photographic means than the one you mention.

NOTES.

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Determination of Radial Motions by Objective Prisms.

Director E. C. Pickering has just issued a further circular (No. 110) dealing with the method adopted at the Harvard College Observatory for the determination of stellar motions in the line of sight. The photographs are obtained with the Draper Memorial telescopes used as prismatic cameras, with large objective prisms placed outside the object glasses. A photograph of all the stellar spectra included in the region covered by one plate having been obtained, the objective prism is then turned through 180°, and then a second exposure on the stellar spectra is given *on the same plate.* It is not necessary or advisable to use two plates, as was formerly recommended. When, owing to special circumstances it is more convenient to reverse the telescope, instead of turning the prism, the plate must in such cases be turned 180°. The corresponding spectra of each star in the two positions may be brought end to end, or in any desired order, by adjustment with a cross-wired eye-piece. If the method were perfect it would only be necessary then to measure the distance apart of the corresponding lines of each pair of spectra, and each star whose radial motion was known would serve to determine the constant distance apart of the lines; the differences in distance, converted into wave-lengths, would then give the required motion of the other stars. Since the motions of the sun and earth are the same for all, these will be eliminated.

The principal sources of error, such as those due to the distortion of the lens, and temperature corrections, are radial, and may be determined by using both co-ordinates of the lines in all the spectra. Any changes in the differential refraction may be reduced by turning the prism so that the spectra become horizontal instead of vertical.

To illustrate the method a sample plate of the Pleiades group is given. On the scale of the spectra given by the 11-inch Draper telescope the probable error in the determination of the motion would be ± 3.5 km. In another series obtained with the 8-inch Draper telescope, covering 10° square, the dispersion is about one-third of the former series, but as the scale is also about one-third, the definition is considerably better, and measures on these may have nearly the same degree of precision. Much fainter stars are shown on the latter plates, lines being clearly defined in stars of the eighth magnitude.

The Coming Total Solar Eclipse, January 13-14, 1907.

Of the six total eclipses which are computed to occur during the next six years, that of 1907 seems least uncertain to yield significant results, and in anticipation of this the local particulars for various stations on the track of that eclipse have been communicated to the *American Journal of Science* by D. Todd and R. H. Baker.

Following the eclipse of 1905, August 30, by an interval of seventeen months, the figure and type of the corona will doubtless have changed considerably, so that it is of the highest importance to photograph the solar surroundings at this opportunity. Fortunately the track is wholly on land, but a great part of the region is so remote and difficult of access, being in Mongolia and the Gobi Desert, that it could be occupied only by equipping tedious and expensive expeditions.

The western half of the eclipse track, however, traverses

Turkestan, a trans-Caspian area penetrated by the Imperial railways of Russia, and, for travellers from the West, can be readily reached by way of Naples, Constantinople, Black Sea, Tiflis, Caspian Sea, Bokhara and Samarkand, or the alternative route *viâ* Berlin, Warsaw, Moscow, Samara, Orenburg, and Tashkent. On this railway about two-thirds the way from Tashkent to Samarkand lies Jizak, which is only a few miles to the south of the eclipse central line. Other easily accessible stations near Jizak, are

Name of Station.	Miles from Central Line.	Latitude North.	Longitude East from G'wich.	Totality Begins.	Totality Ends.	Duration of Totality.	Sun's Altitude.
		° ′	° ′	Local Mean Time.			° ′
				H. M. S.	H. M. S.	M. S.	
Turkestan—							
Chimbai ..	3S.	42 56	59 49	21 19 0·8	21 20 45·1	1 44·3	14 47
Jizak	13S.	40 8	67 48	21 59 58·4	22 1 55·2	1 56·8	21 34
Zaamin ..	15S.	39 56	68 26	22 3 19·5	22 5 17·7	1 58·2	22 4
Ura-tiube ..	2S.	39 59	69 0	22 6 37·1	22 8 40·9	2 3·8	22 21
Nau	14N.	40 8	69 22	22 9 10·5	22 11 5·1	1 54·6	22 29
Sanku.. ..	12S.	39 15	71 13	22 18 49·6	22 20 58·0	2 8·4	24 9
East Turkestan—							
Tagharma Peak ..	2S.	38 32	74 32	22 39 10·3	22 41 18·2	2 7·9	26 27
Posgam ..	8S.	38 15	77 19	22 54 21·4	22 56 39·2	2 17·8	27 50
Yarkand ..	4N.	38 25	77 21	22 54 37·4	22 56 54·5	2 17·1	27 41
— ..	3N.	38 12	79 54	23 10 1·0	23 12 21·02	2 20·0	.. ..
Cherchen ..	3S.	38 2	85 33	23 44 50·8	23 47 12·6	2 21·8	30 14
Mongolia—							
Tsair-osu ..	2N.	44 43	106 41	1 49 41·6	1 51 36·7	1 15·1	19 23

Zaamin, Nau, and Ura-tiube, all well within the belt of totality.

In order to indicate the exact circumstances of the eclipse throughout the length of its track, the local particulars have been calculated for the eleven stations shown above, and an extra possible station between Yarkand and Cherchen included from the British Nautical Almanac.

Stars Having Peculiar Spectra.

A further list of stars showing special features in their spectra have been detected by Mrs. Fleming during her examination of the Henry Draper Memorial photographs of stellar spectra obtained with the prismatic cameras. R. Cygni.—A photograph of this variable star, taken with the 8-inch Draper telescope on November 19, 1890, shows the spectrum of this star to be class Md (Harvard Notation), having the hydrogen lines $H\gamma$ and $H\delta$ bright. On a later photograph obtained with the same instrument on December 7, 1904, the spectrum of this star appears to be of the fourth type, resembling class Na, and shows no trace of bright hydrogen lines.

D.M. + 21° 1609.—R.A. = 7h. 23.3m.; Decl. + 21° 7′ (1900).—This object is in N.G.C. 2392, or identical with it. N.G.C. 2392 was found to have a continuous spectrum, with three bright lines, by Winlock and Peirce, on January 7, 1869, and was later found to be gaseous by d'Arrest. Photographs obtained with the 8-inch Draper telescope on November 21, 1900, and November 27, 1905, show no trace of the bright lines characteristic of gaseous nebulæ, but that the spectrum is of the fourth type. The images of the object on chart plates, however, are hazy, and the image on a photograph obtained with the Bruce telescope on April 16, 1904, shows distinct nebulosity, especially on the preceding and southern edges.

D.M. + 36° 3907.—R.A. = 20h. 5.8m.; Decl. = + 36° 33′ (1900) magnitude = 5.5. The spectrum of this star in Cygnus was obtained on plates taken with the 11-inch Draper telescope on July 4 and November 4, 1905, and shows the hydrogen line $H\beta$ as a fine bright line centrally superposed on the dark line $H\beta$.

Device for Developing Corona Photographs

One of the great difficulties encountered in photographing the solar corona during total solar eclipses is caused by the very great range in intensity of the object; in most cases it is necessary to expose many different plates for carefully arranged times of graduated duration, so that we may obtain records of all parts, from the intense inner corona to the delicate tracery of the outer streamers. If a photograph exposed for any considerable time is developed normally the inner corona is generally so dense by the time the outer details are brought out that it is unprintable.

Numerous suggestions have been brought forward for getting over this difficulty, the most successful hitherto being that of Burckhalter, who arranged a carefully calculated series of rotating screens over his photographic plates during exposure, so that the outer regions received more than the inner parts. These were partly successful in that all parts of the corona could be obtained of printing density on the same negative, but the artificial lines produced by the occulting screens were objectionable. Recently a method has been proposed by Mr. T. Thorpe, which appears to give promise of success. Instead of developing the negative in the ordinary way, it may be mounted on a turntable, and centred so that the centre of the corona is coincident with the axis of rotation. Then by means of a small funnel or pipette mounted on a radial arm also working on the same centre as the plate, begin the development by allowing the developer to fall near the edges of the plate; afterwards gradually approach the stream of developer from the funnel towards the centre, restraining the developer also if found necessary, as it approaches the over-exposed parts of the inner corona. The centrifugal action due to the rotation of the photographic plate will, of course, prevent any of the developer getting nearer the centre than is desired.

BOTANICAL.

By G. MASSEE.

The Periodicity of Sexual Cells in Dictyota Dichotoma.

DICTYOTA is one of the red seaweeds not uncommon on our shores. In common with other members of the group, three kinds of plants possessing different functions concerned with reproduction are present. One set of plants produce antherozoids, or male fertilising bodies; a second batch produce oogonia, or female organs of reproduction; while a third lot of plants produce tetraspores, or asexual reproductive bodies. The antherozoids, which are motile or possessed of spontaneous movement, and the oogonia are respectively liberated at maturity into the water, when the antheroids approach and fertilise the oogonia. Professor Lloyd Williams describes in *The Annals of Botany* the important discovery that this liberation of the sexual organs is periodic. Several crops succeed each other during the summer months, and each crop from the period of its initiation, maturition, and discharge, occupies a fortnight. This periodicity is found to synchronise with the spring tides, and is expressed by the author as follows:—"So intimate is the relation between the tides and the crops of special cells, that a study of the tidal almanac for any locality will enable us to predict the actual days during August and September in any given year on which general liberation and fertilisation of gametes will occur, and even should exceptional conditions prevail, the resulting error will only be about a day earlier or later than the one predicted."

Several factors are more or less concerned in promoting this periodicity, among which are variations in the degree of aëration and of pressure; also differences of temperature and illumination; but the most important stimulus which favours the fortnightly development and liberation of a crop of antheridia and oogonia is the periodic change in the amount of light, as a direct result of the alternation of neap and spring tides.

Plants collected in October and kept growing for several months in a laboratory showed periodicity in the liberation of their sexual organs, and behaved in every way in exactly the same manner as if they had been in the sea. This evidence is considered to indicate that periodicity is a heriditary character.

No periodicity is manifested by those plants bearing tetraspores or asexually-produced reproductive bodies.

Dispersal of Seeds and its Bearing on the Geographical Distribution of Plants.

Dr. Ridley, of the Bontanic Gardens, Singapore, has been studying the rate of dispersal of seeds by wind. They are

grouped under three heads—winged fruits and seeds; plumed fruits and seeds; "powder seed," or dust-like, as orchid seed, fern spores, &c. Winged seeds or fruit is dispersed at the slowest rate, and is unable to cross a wide expanse of sea; the plumed type is well adapted for rapid transit over open country, but is checked by forest areas, whereas "powder-seed" is dispersed most rapidly and to the greatest distance.

The greatest observed distance travelled by the winged fruit of a forest tree, *Shorea leprosula*, was 100 yards. From this it is calculated that this plant could, under the most favourable circumstances, only spread 300 yards in 100 years, and that it would take one and a half million years to spread from the Malay Peninsula to the Philippines, supposing a land connection existed.

Smut.

Smut is the name used by farmers and gardeners to designate certain kinds of fungi belonging to the genus *Ustilago*, which form black powdery masses in the ears of oats, barley, wheat, and various other grasses; also in the anthers of some flowers, as *Scilla*, *Lychnis*, &c. In the case of oats infection can only be effected when the plant is in the youngest seedling stage. The fungus spores are dispersed by wind, and retain their vitality until the following spring, when they germinate on any decaying vegetable matter present in the soil, usually manure; the germ-tubes pierce the delicate tissue of the oat plant immediately after germination. After infection the mycelioma of the fungus grows up along with the oat plant, without producing any injurious effect, until the flowering stage, when the fungus enters the ovary and produces a black sooty mass of spores in place of the fruit. Maize, or Indian corn, it has for some time been known, can be infected at any point where very young tissue is present, but with this exception it has up to the present been considered that all other cereals could only be infected during the seedling stage, as described for the oat. Brefeld, a German botanist well-known for his many and important contributions towards the life-history of fungi, has recently been studying the smuts attacking cereals, and has proved by experiments that the smut spores of barley and wheat can only infect the plant through the flower. The spores alight on the stigma, where they germinate and penetrate the ovule, remaining there until the following season. When such infected seed is sown, the fungus grows up along with the plant, and eventually produces smut in place of grain in the ear.

In some instances the fungus spores are dispersed by wind, in others they are carried to the stigmas along with pollen by butterflies. In the case of aquatic grasses, the fungus spores are conveyed by water.

This discovery adds wheat and barley to the already considerable number of economic plants of primary importance, whose most destructive enemy in the form of a parasitic fungus, can be conveyed from one district or one country to another in the form of mycelium present in the seed, tuber, bulb, &c. In this condition detection is impossible, and the danger of introducing disease into a new district considerably augmented.

Mosses as Storers of Water.

Experiments conducted by A. Cserey show that some abundant kinds of mosses, as *Hypnum*, *Dicranum*, *Sphagnum*, &c., absorb about six times their own weight of water in less than a minute, and require seven days wherein to give it all up again. This function is probably of much service on steep slopes, where an excessive rainfall if not checked would prove very destructive, and, further, by slow liberation of water the humidity of the air is, to some extent, secured.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

A Physiological Test for Copper.

It has frequently been noticed that the leaves of plants that have been treated with a solution of copper sulphate show abnormal deposits of starch. This is evidently due to the poisonous action of the metal upon the enzyme diastase, which converts the starch of the plant cells into sugar, and it has been found by Herr Ewert that a minute trace of copper sulphate (0.0000051 gramme) is sufficient to produce this paralysing effect upon diastase left in contact with a very dilute solution of starch. On this fact he has based a very delicate physiological test for traces of copper. A plant watered with a dilute solution of copper sulphate at once begins to deposit the starch, and the latter can easily be recognised by the characteristic blue coloration that it gives with iodine. The leaves of a plant thus treated give the reaction after about an hour and a half, whereas the leaves of a normal plant do not turn blue on treatment with iodine.

The Origin of Fusel Oil.

Fusel oil, long regarded as an objectionable waste product in the manufacture of spirit, has latterly become an important article of commerce, owing to its use as the basis of a solvent for guncotton, in the manufacture of smokeless powders, and for artificial fruit essences, and experiments have been made to find a means of obtaining it in larger quantity. The most important discovery in this direction is that made by Dr. Ehrlich, of Berlin, who finds that, contrary to the generally accepted view, fusel oil is formed, not by the action of certain bacteria upon sugar, but by the yeast itself acting upon nitrogenous compounds, such as the amido acids invariably present in decoctions of malt. It transforms these compounds into amyl alcohol (fusel oil), and ammonia, the latter being utilised in building up the protein of its own cells. Dr. Ehrlich also finds that it is possible so to arrange the relative proportions of yeast and sugar that any given amount of the amido acid (leucine) may be added to the fermenting liquid and converted into fusel oil, which may subsequently be separated from the main product (ordinary alcohol) of the fermentation. An abundant source of leucine is found in numerous bye-products rich in nitrogen, such as horn shavings and the waste liquors from the manufacture of glue, and this discovery of Dr. Ehrlich indicates the possibility of establishing an important branch of industry in connection with the manufacture of spirit.

Earth-Eaters and their "Food."

Eaters of earth have been known for centuries, and to this day are found in Guinea, Senegal, and New Caledonia, and in various parts of South America. The French naturalist, M. Courty, who recently explored the high tablelands of Bolivia, states that the Indians there are very fond of a paste of clay, which they mix with coca leaves; but as a rule the earth-eaters take the clay by itself in the form of little pellets dried in the sun or over a slow fire. It has been asserted by certain explorers that the particular earth eaten has really some nutritive value. Humboldt, for instance, writing in 1800, mentioned that the Indians on the banks of the Orinoco consumed as much as one and a half pound per day of earth, "qui paraît être nourissante." Two specimens of these earths exhibited in the last Paris Exhibition have recently been examined by M. Balland. One of them, from Gabon, was a light-grey powder, consisting of about 95 per cent. of silica, about 4 per cent. of iron oxide and alumina, 0.5 per cent. of water, and traces of magnesia, etc. The other specimen, from New Caledonia, was of a yellow colour, and contained about 98 per cent. of silica, 0.4 per cent. of magnesia, and 0.8 per cent. of water, with traces of sulphate but was free from iron, alumina, or lime. A New Caledonian product, analysed in 1801 by Vaquelin, contained 18 per cent. of iron oxide and 2 per cent. of copper, the remainder being chiefly silica and magnesia. It is thus evident that these earths have no value as food, and may even be injurious when containing copper, although it has been pointed out that they may have a negative value as a supplement to a diet devoid of woody fibre, *e.g.*, fish, their mechanical action aiding in the division of the food and thus indirectly promoting digestion.

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GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The New President of the Geological Society.

SIR ARCHIBALD GEIKIE, whose recently published "Founders of Geology" we notice in another column, and who has already filled the Presidential chair of the Geological Society with distinction, has again been elected as President for the next two years, in place of Professor J. E. Marr, F.R.S., who retires.

Beneath the Earth's Crust.

The question which is being discussed elsewhere in this journal as to what is at the centre of the earth is of extreme interest to geologists, not solely on account of its bearing on the problem of underground heat, but indirectly as possibly affording some clue to the variations in climate in past geological times. Geologists at one time did not hesitate to ask that a change in the direction of the earth's axis should be admitted, in order to explain the existence of fossil tropical plants in what are now the frozen regions of North America, a fact now apparently equalled by similar discoveries in southern polar regions. Mr. De St. Dalmas' contribution in "KNOWLEDGE" has usefully brought to mind the great Halley's theory of a solid revolving nucleus, although in his day he could scarcely have realised the bearing which, if proved to be correct, it would have on future geological science. Not only are we still with absolutely no clue to the cause of the existence of a magnetic pole at all, but there is no satisfactory theory to account for fossil vegetable life bearing a tropical facies in parts now bordering on Arctic regions. Halley's theory that there is practically a solid nucleus is accepted by most people. But his theory that its axis is at an angle to that of the earth, that its poles are the points towards which the needle dips, and that the movements of the magnetic poles are caused by a swaying motion of its axis around our poles, are points which have entirely dropped out of consideration.

Refraction of Earthquake Shocks from the Centre Core of the Earth.

The question of the constitution of the interior of the earth, as revealed by earthquakes, has just been the subject of a paper by Mr. R. D. Oldham, F.G.S., which was read at Burlington House before the Geological Society. It is particularly interesting, in view of the discussion now going on in our columns. The distant record, he says, of a great earthquake exhibits three distinct phases, of which the third represents wave-motion which has travelled along the surface of the earth and is not dealt with in his paper, as it can give no information regarding the interior of the earth. The other two phases form the preliminary tremors, and it is shown that they represent the emergence of two distinct forms of wave-motion, which have been propagated through the earth. He thinks that the wave-paths emerging at the greater distances have entered a central core, in which the rate of transmission of the first-phase waves is reduced to about nine-tenths, and of the second-phase waves to about one-half, of the rate in the outer shell. The great reduction of rate in the case of the second-phase waves means great refraction.

Mr. Oldham's researches lead to the conclusion that, after the outermost crust of the earth is passed, there is no indication of any material or rapid change of physical condition, nor probably of chemical composition, until a depth of about six-tenths of the radius is reached; but that, below this, there is a rapid passage to matter which has very different physical properties, if not also differing in chemical constitution. Without advancing any hypothesis as to the nature of this difference, he points out that it will have to be reckoned with in any theory of the earth. In the discussion which followed, the President observed that there could be little doubt that we were on the eve of important additions to the data available for discussing the subject.

At a meeting of the Geological Society on February 21, Miss Ethel M. R. Wood's paper on "The Tarannon Series of Tarannon" was read, the discussion being contributed to by Miss Elles. Mr. G. E. Dibley exhibited a dental bone of *Coniosaurus crassidens* (Dixon) from the *Holaster-subglobosus* zone of the chalk of Burham, near Rochester.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Plumage of the Shoveller.

AT the last meeting of the Ornithological Club Mr. J. L. Bonhote exhibited a fine series of skins of shoveller ducks (*Spatula clypeata*), illustrating the fact that this species differed, so far as he knew, from all other ducks, in having an *intermediate* plumage between that of the "eclipse," the full breeding plumage.

Hitherto birds in this plumage had been regarded as immature birds, but the difference between these and the adults was shown unmistakably. Thus, in this intermediate plumage the head is much darker than in the "eclipse" dress, without metallic gloss, while the feathers of the chest were white, with dark brown bars and a buff margin. Young birds also assume this intermediate plumage in their first year, but they may always be distinguished by having the white feathers of the breast *spotted* instead of barred.

This peculiar dress succeeds the "eclipse" plumage in September, and is gradually replaced by the full breeding dress, which, however, is not completed until the end of March.

Hybrid Black Game.

At this same meeting Mr. W. P. Pycraft exhibited a remarkably fine male hybrid between black game and pheasant, which had been shot at Ringford, Kirkcudbrightshire.

In this specimen the character of the males of both species were about equally divided. The head, neck, and under parts were of a rich glossy black with green reflections, but the flank feathers showed traces of the mahogany red and black characteristic of the pheasant. The peculiar notched feathers of the neck and breast which obtain in the pheasant were wanting The scapulars resembled those of the young blackcock, but the coloration of the back differed from that of either parents. The tail was fan-shaped, mottled with fine markings of black and brown, and without bars. While the quill feathers were like those of the pheasant, the coverts, like the back, resembled those of neither of the parents. The rump feathers were rounded in shape, not pendant and discontinuous as in the pheasant. As in the pheasant, the space around the eye was bare, though the area was smaller than in the pure-bred bird. The beak was of a pronounced pheasant type, but the nostrils were feathered as in the blackcock. The legs were feathered for about one-third the way down, but the scaling below resembled that of the pheasant only in so far as the outside of the lower third of the tarso-metalarsus was concerned, the rest of the scales being hexagonal in shape; while the comb-like fringe along the toes was conspicuous by its absence.

It is believed that this bird represents only the seventh known instance of the cross.

Greenland Falcon in Antrim.

In the *Irish Naturalist* for March, Mr. Robert Patterson records the fact that a male Greenland Falcon (*Falco candicans*) was shot on the top of the mountain called the Knockagh, near Carrickfergus, on February 12 last. The last record of this species in Antrim was in 1865.

Bittern in S. Wales.

"G. W. V." writes to the *Field* (March 10) to say that when shooting in South Wales last month he put up a bittern, and shortly after found another dead, "which had

evidently been shot." We join with him in his expressions of regret, and agree further that "It is possible that these two were a pair and might have remained to breed."

King Eider in Orkney.

Mr. H. W. Robinson records (*Field*, March 17) the fact that an adult female of the king eider (*Somateria spectabilis*) was shot off the west of Graemsay, Orkney, on February 21.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Resolving Power with Wide Slits.

In the ordinary use of a diffraction grating or prism, it is found to be necessary to use a very narrow slit if two very close spectral lines are to be seen separate from one another; because each line as seen is simply an image of the slit employed. The grating is used with the light falling nearly normal to it; while a prism is usually set in the position of minimum deviation (*i.e.*, the position for which the incident and emergent rays make equal angles with the normals to incident and emergent face respectively).

Mr. Morris-Airey, in a paper in the *Philosophical Magazine* for March, shows that quite wide slits, or even no slit at all, can be employed without any sacrifice of resolving power, if the grating or prism be placed so that the light strikes it at nearly grazing incidence. Schuster had previously shown that the purity of a spectrum (which is a measure of the smallness of overlapping of images arising from different wave-lengths), is given by

$$\frac{1}{\text{Purity}} = \frac{(\delta\lambda)}{\lambda} = \frac{2\lambda + A\omega}{\lambda R}$$

where $(\delta\lambda)$ is the smallest difference in wave-length which will give distinctly separable images. A is the angle subtended at the slit by the lens of the collimator; w is width of the slit; and R is the resolving power corresponding to an infinitely narrow slit.

Now, Morris-Airey points out that A should not refer really to the angle subtended by the collimator lens, because only part of the complete beam of light passing through this lens may fall upon the grating. The effective portion of the lens is that which corresponds to the width of beam received by the grating or prism, and this is very small when the grating is placed in a very oblique position. But as A becomes small, w may be proportionately increased without any loss of purity; and, in fact, slits half a centimetre wide may still allow separation of the two yellow lines of sodium with a 1300 line grating. Owing to the magnificent casts of Rowland's grating, made by Mr. Thorp, of Manchester, which are on the market, good gratings are much more common possessions than once they were. All who own any such grating can obtain much more power out of them than has commonly been thought. For it is clear that if the slit be not widened when the grating is placed obliquely, *greater* purity will be obtained. A limit to what can be gained in this way comes in owing to the great loss of light for great angles of incidence. But it would seem that it is only transmission spectra which will be affected in this way. For reflection spectra, the increased reflecting power is an additional advantage which will enable a narrower slit to be employed. Anyone who wishes to show spectra on a screen to an audience will find it an immense advantage to make use of the above facts. The present writer has just set up a Rowland reflection grating with a slit 2 cms. wide, and with the grating very oblique. The lines of the "Swan spectrum" stand out as quite narrow bands. The spectra obtained are so brilliant that 10 or 12 can easily be obtained. The increasing effect of overlapping as the order of spectrum increases is very instructive. After the first few, the remainder appear as a succession of reds and greens, very similar in general effect to the tints of Newton's rings of high order. Of course, in the case of metal gratings not much advantage is to be expected because at normal incidence the reflecting power is at least 90 per cent., but in the case of glass ones very considerable gain may be obtained in exhibiting the reflection spectra.

Secondary Spectra.

While discussing a diffraction grating it may be interesting to point out that, besides the spectra usually seen, theory shows that there are a large number of very much feebler ones between each pair of principal spectra. These are the secondary spectra. They must be distinguished from "ghosts," which arise simply from irregularity in the ruling of the grating. Their number between two principal maxima is very great—practically the same as the total number of lines in the grating; thus there will be as many as 80,000 on a 14,000 line grating six inches wide. In practice, they are invisible, and it is usually asserted that this is to be expected when the number of lines is large. It is at any rate certain that when the number is small they are very visible. They may be obtained as follows: Cut four parallel slits in a piece of thin brass or aluminium sheet, each slit a millimetre wide and with an interval of 1 mm. between each. Now by means of a long focus lens focus a narrow and very bright source of light (suitably obtained by putting a very narrow slit in front of the condenser of a lantern, with the lens removed) upon the focal plane of an observing eye-piece, and interpose the four opening grating just in front of the lens so that the light can only pass through the four openings. Take care that the sides of the openings are parallel to the slit. On looking through the eye-piece, a diffraction pattern will be seen consisting, if a piece of red glass be interposed, of a central principal maximum (the direct image), followed by two feeble secondary maxima; then a second principal maximum (the "first order spectrum,"); then four feeble secondary; then another principal one (the "third order spectrum"—the second order is absent in this case). Everything is repeated in the same way on the other side of the central image.

Now it is easily calculated that the relative intensity of any principal maximum and the secondary maximum next to it is not very much greater when there are 80,000 lines than what it is when there are only a few. The reason that they are not visible in practice is that even the principal ones are always comparatively feeble, so that their feeble satellites are beyond detection. If, however, the "direct image" formed by any grating be examined, the satellites are quite conspicuous. With a 20,000 line Rowland grating about six can easily be seen on each side of the direct image—those of the six being more and more evanescent as they are more removed from the centre. This simple observation is sufficient to show that there is considerable agreement between theory and practice even in minor details, although an examination restricted to the lateral spectra seemed to indicate that there was some disagreement. This is by no means the only case in which a peculiarity in the effect seen is due simply to imperfection in our sensations of vision.

The Joule-Thomson Effect.

When a gas is forced through a porous plug, it is usually at a different temperature at the two sides of the plug. Considerable interest has centred round this fact, because it can be shown that if a gas were a perfect gas (*i.e.*, one satisfying accurately both Boyle's Law and Charles' Law) it should undergo no change in temperature in such an experiment. In reality, it is found that most gases cool at ordinary temperatures in passing through; hydrogen, however, is an exception, it gets slightly warmer.

Olszewski, some years ago, showed that when hydrogen is at a temperature of about 80 degrees C. below zero, it does not change temperature when forced through a plug. This temperature is known as the "inversion temperature," because, for temperatures below it, cooling takes place instead of heating.

It now appears, however, that most probably this point is not a unique one, and that it all depends upon the pressure of the gas as to what the inversion temperature will be. There is no direct determination except the one quoted above. But calculations based on equations of state, which fairly satisfactorily represent the observed connections between the pressure, volume, and temperature of a given

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mass of a gas when these change, are all unanimous in indicating that for each pressure of a gas there are two inversion temperatures (if any), but that above a certain pressure there will be none. The last statement is equivalent to asserting that if hydrogen be sufficiently compressed, it will undergo warming in passing through a porous plug, whatever its temperature may be. Further experiments are badly wanted on this subject; and if it should turn out that the above prognostications are not realised, it will merely show that the true equation connecting pressure, volume, and temperature, is not the one upon which the conclusions are based; and we have here, indeed, a most sensitive means of obtaining information about this equation.

ZOOLOGICAL.

By R. LYDEKKER.

A New British Fish.

AMONG British freshwater fishes few are of greater interest than the group represented by the Lochmaben vendace (*Coregonus vandesius*), the Irish pollan (*C. pollan*), and several other more or less closely allied forms, each confined to a single lake or group of lakes. All these fishes are members of the salmon tribe, and are near akin to a marine species; the latter fact indicating that they were at one time in all probability migratory, but have now become confined to the lakes they respectively inhabit. This isolation is doubtless the main factor which has led to the distinctness of the various species. A further illustration of this tendency to differentiation is afforded by the recent discovery (detailed in the February issue of the *Annals and Magazine of Natural History*) that the vendace of Derwentwater is distinct from, although nearly allied to, the Lochmaben species. In allusion to its slender build, it has been named *Coregonus gracilior*.

The White Winter Coat of Mammals.

Much ink has been spent in discussing the question as to whether animals like the stoat, which in high northern latitudes turn white in winter, do so by changing their coats, or by the bleaching of the hairs of the dark summer dress. It has been demonstrated that the senile whitening of human hair is due to the presence of phagocytes, which devour the pigment-bodies; and from microscopic observations recently made by the well-known French naturalist, Dr. E. Trouessart, it appears that much the same kind of action takes place in the hairs of mammals that turn white in winter. Cold, by some means or other, causes the pigment bodies to shift from the normal positions, and to transfer themselves to other layers of the hair, where they are attacked and devoured by phagocytes. The winter whitening of mammals is, therefore, precisely similar to the senile bleaching of human hair, no shift of the coat taking place. Under the influence of exposure to intense cold a small mammal has been observed to turn white in a single night, just as the human hair has been known to blanch suddenly under the influence of intense emotion, and in both cases extreme activity of the phagocytes is apparently the inducing cause. Dr. Trouessart's paper is published in the *Comptes-rèndus* of the French Biological Society for February.

A Dwarf Elephant.

As the heart of Congo-land is the home of dwarf representatives of the human race, so, according to a German naturalist, it is the abode of a diminutive race of the African elephant, which probably does not exceed five feet in height. The interest of this dwarf elephant centres in its relation to the extinct pigmy species of Malta and Cyprus, whose teeth indicate that they were nearly allied to the African animal.

The Horns of the Wild Sheep.

It is a well-known fact that the horns of several species of wild sheep are always more or less damaged at the tips. This has been explained by some as due to the animals fighting, or to their raking up the snow and ground in search of food; the latter theory not accounting for the fact that it is only the horns of old rams which are thus damaged. In a recent issue of *Shields' Magazine* Captain C. E. Radclyffe offers the following explanation :—

"My own opinion is that the tips are worn down intentionally, and that this is done by rubbing the points of the horns against rocks. On inspection we find that the tips are worn away, as if rubbed with a coarse file, and are not broken off. If the latter were the case the remaining ends of the horns would be more split and fractured than they are." . . . It seems that when the horns attain a certain size and shape their points interfere with vision, and in some cases also with feeding; for occasionally they grow into such a shape that when the rams are grazing their points, unless reduced in length, would come into contact with the ground. Somewhat remarkable powers of reasoning are thus attributed by the author to wild sheep.

The editor is indebted to the author, Mr. C. O. Esterby, for a copy of a paper on the nervous system of the copepod crustaceans, recently issued by the University of California at Berkeley.

Papers Read.

At the meeting of the Zoological Society on February 6, Dr. J. W. Jenkinson read a paper on the Ungulate placenta, Mr. E. S. Russell described a new hydroid polyp, and Miss Ricardo a new horse-fly; while Mr. H. Schwann communicated notes on a collection of African mammals, and Mr. Lydekker described others collected by Major Powell-Cotton. The most important paper was, however, one by Mr. H. G. F. Spurrell on the modes of articulation of the vertebrate lower jaw. At the meeting of the same Society on February 20, Messrs. Doncaster and Raynor described experiments in breeding Lepidoptera, Mr. W. P. Pycraft read a paper on certain passerine birds, Messrs. Thomas and Schwann gave notes on African mammals, and Dr. B. Dean discussed the habits of the Australian lung-fish.

Protection of Birds.

IT is pleasing to note in the annual report of the Society for the Protection of Birds, that some humane restrictive laws are having good results. For example, Lord Curzon's order in India prohibiting the export of plumage, an order which had the support of native religious sentiment in India, has considerably reduced the output, though Indian bird skins and feathers still offered at the London plumage sales show that the order is evaded. The stationing of watchers at Dungeness and on Lundy Island for the protection of sea birds has done good also; and peregrines and buzzards are now nesting on Lundy. The gannets of the Bass Rock are now secure from the guns of idiot trippers; and it is hoped that the St. Kilda wren will be rescued from threatened extinction by the Inverness order of last summer. On the other hand, the decrease of swallows is still unaccounted for, and there is little hope of saving goldfinches from the imprisonment in the cages of London slums and birdshops to which the Sunday birdcatcher dooms him, unless Sunday were made a close day. That the goldfinch and the kingfisher will recover their number if protected has been shown.

MESSRS. NEWTON, scientific instrument makers, have taken into partnership Mr. Russell L. Wright (son of the late Mr. Lewis Wright, the author of "Light" "Optical Projection," &c.), who has been for some years their works manager and head of their electrical department.

New Dinosaurs.

There seems to be considerable rivalry between New York and Pittsburg, Pa., on the subject of the gigantic reptiles of the Mesozoic age. Hardly had the former town recovered from its ecstasy at the possession of what it fondly believed to be the "biggest reptile on record," in the person of the fine Brontosaurus, presented by Pierpont Morgan, than it learnt to its chagrin that Pittsburg was still leading by a head and about fifteen vertebræ—to be exact, by 17 feet 9 inches, thanks to Andrew Carnegie's Diplodocus, the plaster cast of whose skeleton we have all seen and admired at the South Kensington Museum. Why, we may ask parenthetically, do the Mesozoic reptiles exercise such fascination over American millionaires? Is this an instance of elective affinities? Honours, however, are now easy between the rival towns, for the latest addition to the American Museum of Natural History in New York is the fossil remains of a Tyrannosaurus, the largest carnivorous land animal yet discovered, and the most ferocious monster of the Reptile Age. He was nearly thirty feet shorter than the herbivorous Brontosaurus, but was in every way more formidable, and was distinguished from the other dinosaurs by his agility, his superior brain, and his massive structure. He had immense feet—four feet long by three feet wide—and his total length was thirty-nine feet, while some of his teeth measured as much as six inches.

The first bones of Tyrannosaurus Rex, to give him his full title, were brought to light as long ago as the summer of 1902, at Hell Creek, in the bad lands of Montana, which have proved a veritable graveyard of prehistoric animals. During the summer of 1905, a second expedition was dispatched to the same place and a number of additional bones were excavated from a sandstone as hard as granite. The discovery comprised so many representative portions of the skeleton of the great flesh-eating dinosaur that the general appearance of the animal can be described with some approach to accuracy. While we may lament the disappearance of the placid Brontosaurus or the fragile Diplodocus, we have every reason for congratulating ourselves that Tyrannosaurus Rex is not our contemporary. He was practically a biped, with an agile, bird-like manner of progression, the immense feet possessing three enormous toes projecting forward, and one extending backward—all furnished with huge tearing claws. The head is much larger than that of the Brontosaur, and the great teeth are serrated and sharp-edged. Tyrannosaurus seems to have come in about the time that Brontosaurus went out—perhaps he materially hastened the departure of the latter. When these monsters roamed the earth, Montana possessed a sub-tropical climate, not unlike that of the West Indies to-day, the region including great seas of salt or brackish water, the sedimentary remains of which form the "bad lands" of our day.

A curious point with regard to the recently discovered plesiosaurian remains in Western Kansas, was the reason for the large pebbles found in the neighbourhood of the extinct reptiles. These huge pebbles were found inside the remains of the fossilised plesiosaurs, and it was alternatively suggested that the extinct monster swallowed them as birds swallow small stones to aid the gizzard in the processes of digestion, or that the animal may have had some idea of increasing its specific gravity by adding stones to its weight in order to sink to the level of the mud bottom where its food was found. It will be observed that doubt and even ridicule have been thrown upon the supposed bird-like digestive habits of these creatures. But according to Professor S. W. Williston, the cumulative testimony of writers both on this and the other side of the Atlantic is quite conclusive. It has been assumed that the plesiosaurs could not have utilised the pebbles as a means of digestion in a muscular stomach. But the modern crocodiles have a real, bird-like, and muscular gizzard; and it is believed that they have a similar habit. At any rate the habit has been imputed to them, and it is not stretching theory too far to believe that the plesiosaurs had similar muscular gizzard-like stomachs and originated the pebble-swallowing habit. The special plesiosaur with which the habit is associated is the *Elasmosaurus*, which of all animals either past or present had the longest neck recorded. It had no fewer than fifty-eight vertebræ in this portion of its frame, and its total length of neck may be modestly estimated at twenty-three feet. The length of its trunk was nine feet, of its tail eight feet—a great contrast to the *Diplodocus*. The extreme length of the largest-known specimen was probably sixty feet. As to the habits of these long-necked plesiosaurs in life, it seems most probable that they were general scavengers, usually living in shallow waters.

An Ancient Mazer: An Old Wassail Bowl.

By Barr-Brown.

A Mazer of great antiquity is now used as an alms dish in St. John's Church, Glastonbury. It is one of the most beautiful and ornate examples in existence. It has been described as a "brass or latyn-bowl." It is

Photo by W. Tully, Glastonbury.

An Ancient Latyn Dish.

circular in form and in diameter is sixteen and a half inches. The flat rim is two inches broad and its "depressed inside seven-eighths of an inch in depth." On the face of the rim are two borders a little indented one within the other. In the centre or bottom of the dish

is a circular compartment, including an historical legend in bas relief of St. George and the Dragon. There is also King Ptolemy and his Queen, with Sabra, their beautiful daughter. On a thick rim is the ancient inscription:—"Ich Bart Geluk Alzeit; Bart Geluk Alzeit." "I brought good luck always."

The language is that of the Low Countries, which marks it as being of Flemish manufacture; the form of the lettering and the costume of the knight and his palfrey points to an antiquity as remote as the beginning of the 14th century. In the old almshouses founded by Edward VI. at Saffron Walden is preserved an ancient and very valuable wassail-bowl of brown wood with a silver rim, and a medallion in the centre with the Virgin and child engraved on silver. Its date is about 1400.

A New Oxide of Carbon.

BY the action of the silent electric discharge on carbon monoxide, Brodie, in 1873, obtained a reddish-brown product which appeared to be an oxide of carbon; to this product the formula C_4O_3 or C_5O_4 was assigned, analysis giving somewhat variable numbers.

Berthelot, in 1876, made similar observations and found also that the brown amorphous product which he obtained, gave, on heating, in addition to carbon monoxide and dioxide, a dark coloured substance having the composition C_8O_3.

With the exception of these somewhat indefinite products, which have since received but little attention, chemists have up to the present time recognised only the two well-known oxides of carbon—the monoxide and dioxide.

It is, therefore, a matter of considerable interest to learn from Diels and Wolf (Ber. Deut. Chem. Ges. February, 1906, 689), that they have isolated, in a state of purity, a new and definite oxide of carbon having the formula C_3O_2. It is prepared by the action of phosphorus pentoxide in considerable excess on malonic ester, the change being represented by the relation:—$CH_2(COOC_2H_5)_2 = 2C_2H_4 + 2H_2O + C_3O_2$ This new oxide—carbon sub-oxide, the authors term it—is a colourless mobile liquid, which boils at 7°; it has an intensely pungent odour, somewhat resembling that of acrolein or of mustard oils, and burns with a sooty blue-edged flame. The composition was determined by combustion, and by explosion with oxygen and the molecular weight by vapour density determination.

When mixed with water, it dissolves immediately, forming malonic acid, and ammonia in ethereal solution converts it into malonamide. From these and other properties and from its mode of formation, it may be regarded as an anhydride of malonic acid, and the authors consider that its constitution is represented by the formula O:C:C:C:O.

By spontaneous decomposition, a dark-red amorphous substance is obtained, which dissolves in water, giving an intensely red solution.

H. J. H. FENTON.

ERRATUM.—In the article by Mr. C. A. Mitchell last month on Poisonous Plants used for catching fish, the expression "natural order Derris" should be read as "genus," the latter expression having been used by a slip of the pen.

Thickness of the Earth's Crust.

By FRANK HARRIS.

THE persistent survival of gross popular fallacies long after their falsity has been clearly demonstrated, is one of the most gloomy features in man's intellectual outlook.

Some popular errors are, of course, much more reasonably excusable than others; to imagine the earth is fixed in space and devoid of motion is but to accord unthinking belief to the immediate evidence of our senses; and foolish only in that it fails to take into account the evidence presented by all except the most violently striking of celestial phenomena. Far otherwise is it with the popular belief that the earth consists of a globe of molten matter enclosed in a solid shell no thicker in proportion to its size than is the shell of a hen's egg to its contents; and that assumption of which this belief is the outcome, that the increase in temperature noticeable on penetrating the earth to trivial depths continues without limit towards the centre; for, not only can the first supposition be easily proved to be absolutely impossible, as can the fixity of the earth in space, but also is there no excuse whatever for the second assumption upon which the first is based; it is an utterly illogical conclusion from our premises.

If the earth contained any masses of dense fluid matter *very* great compared with the thickness of the enclosing shell, that shell, even if constantly repaired, would be utterly shattered twice in every twenty-four hours by the moon's tide-compelling action on the fluid mass.

If the earth had at any time consisted of a globe of matter all at one temperature, say 7,000° F., and the surface had been suddenly cooled down to its present temperature and so maintained, in one thousand million years the variation in temperature would be quite insensible at depths exceeding five or six hundred miles; and the variation near the surface—taking a reasonable co-efficient of conductivity—would be in 100,000,000 years very nearly what is now actually observed.

We need not, either, suppose the surface to be suddenly cooled as in the abstract problem. Rock is so poor a conductor of heat that as soon as the surface was solid, a few thousand years—at most say one million—would amply suffice to allow the actual surface to cool down to a temperature so near that now existing as to satisfy the supposed conditions.

There is, therefore, no reason whatever for supposing that the increase in temperature does not rapidly tend to a limit within a short distance of the earth's surface. It is easy to form an approximate idea of what this limiting temperature will be.

Supposing, for simplicity, that the earth consisted uniformly of granite; the limiting temperature would be just below that at which granite solidifies under the pressure to which it is there exposed.

It makes no difference in essential principle whether we suppose the earth originally to have consisted of a globe of molten granite--as might result upon condensation from a nebula or upon adequate collision between two approximately equal masses; or whether we suppose it originally consisted of a solid nucleus surrounded by

an ocean of molten rock—as might have resulted from collision between one large and, possibly, sundry smaller masses; in either case it is easy to see what its future history would be.

Radiation taking place from the surface only would tend to rapidly lower its temperature there. Convection currents set up in the fluid hereby would constantly maintain an approximately equal temperature throughout the fluid mass; for in a fluid which is of low conductivity the effect of conduction is utterly insignificant compared with that of convection. Thus it follows that the temperature would be lowered about uniformly throughout the fluid, so long as fluid existed, and when solidification began the whole would be at about the same temperature, and this temperature would be approximately maintained until the whole was (with the exception of pockets of more fusible matter) completely solidified, for in this case, of course, solidification would take place from the centre outwards.

Independently, however, of any assumptions we have here made and of any particular hypothesis, the fact to which we would draw attention is indisputable—there is no reason whatever for assuming that because the temperature increases with the depth it does not rapidly tend to a finite limit. This fact was clearly demonstrated by Thomson and Tait in their Natural Philosophy published a quarter of a century ago.

MR. EDWIN LITCHFIELD sends a short article on this subject. After some introductory remarks which have already been imbodied in our previous articles, he continues: "The deeper a mine is, the higher the temperature. Let one be sunk half a mile deep, and then, by gigantic labour, make the mine into a valley of ten miles radius—the heat would be gone. Standing on the Welsh or Irish coast, the ground is not hot; dive down into the Atlantic; the "Challenger" did not find the waters beneath to be hot (rather cool), and yet they were five miles nearer the centre of the earth. The cause of heat in mines is from pressure of the 40 odd miles of air above, we sink out of our element, and, I suppose, let the air down out of its; and possibly the gases in the earth exude, and, pressed down by the air above, produce heat.

This is fact. Cold air from the mountains in Switzerland, passing above the valleys, and the sun's rays penetrating the cold particles, cause the undue heat in the valleys. In Melbourne, the cold wind from the South Antarctic blowing above the warm air from the North and not letting it rise, causes the burning-hot wind which lasts till the cold becomes the master. Often in this island we find cold weather follows unusual warm days, from the same cause.

Were a mine to be sunk through carboniferous rock, and another of even depth, through chalk, the former would be much hotter than the latter. It is also out of all conception that the crust of the earth in cooling could bottle up and enclose 7,000 miles diameter of intense heat. Should that amount of molten heat, or intensely hot gases be in the interior let us hope it never gets a vent—it would overwhelm the earth and sea.

We must raise some other idea to account for volcanoes and hot springs. I am not aware that the Laurentian, the first formed rock of our globe, so far as we yet know, shows sign of having been burnt, and deep borings have been sunk into Silurian rocks and yet the water comes up cold.

We might try and find some other reason why deep mines are warmer than the top of the Alps.

REVIEWS OF BOOKS.

Elements of Geology, by W. H. Norton Ginn and Co., the Athenæum Press, Boston, U.S.A., pp. 449 and index; 6s. 6d.).—There is scarcely a page in this book which has not its appropriate illustration or diagram, and to British geologists the many instances of geological phenomena drawn from the American Continent will prove of great interest and utility. Truly science is a strengthener of the amity of nations, and geology bids fair to bind still firmly together the inhabitants of the old and new worlds. We like the arrangement of this book. The stiffness of arrangement into various departments—dynamical, structural, physiographic, historical—has been abandoned, and as each geological process is reviewed, the land-forms and rock-structures which it has produced are treated in turn. The illustrations are, for the most part, small, but they have not suffered in the process of reduction. The various phenomena portrayed are clear and distinct, and excellent as is the advice that study in the field is absolutely necessary to the young geologist, it is not possible for any but a few to travel to the scenes which are here described. Accurate photographs are, consequently, of the greatest importance, and here we have a sure and safe guide. It is impossible to select any one portion of the book as more deserving of special notice than another. The Professor of Geology in Cornell University has done his work well, and we have much pleasure in calling attention to his book.—E. A. M.

Hints to Meteorological Observers (prepared under the direction of the Council of the Royal Meteorological Society, by William Marriott, F.R.Met. Soc., Assistant-Secretary. 6th edition revised and enlarged with illustrations, pp. 70 with frontispiece; 1s. 6d.)—This valuable work is now brought up to date, and enlarged and provided with excellent illustrations, showing a great advance on the first edition of a quarter of a century ago. A comparison of the two will show the great advance made in meteorology during that period, as evidenced by a short list of some of the additions shown by a comparison between these two editions. Not having a copy of the intermediate editions, this is the only course open to us. This list includes such familiar subjects as Sunshine Recorders, Self-Recording Instruments, Kites, Phenological Observations, and Dines' Pressure-Tube Anemometer, showing that these are either new, or, at any rate, were too rare 25 years ago to be included in a handbook designed for the use of the ordinary meteorological observer. If there is one science which appeals to a large class as an interesting and by no means difficult or expensive way of increasing the world's knowledge, it would seem to be meteorology. The laborious night watches and heart-breaking conditions of "seeing," which press hardly on the astronomer, especially in later life, are almost unknown to the climatological observer, who, if his habits are regular and his health good, will find little difficulty in maintaining an unbroken and, therefore, valuable series of daily observations. To anyone looking for work of this kind we can confidently recommend Mr. Marriott's "Hints," which contain practically all he can want to know about instruments and their careful manipulation, with useful illustrations, tables, very much enlarged in the 6th edition for reduction and computation of various elements, conversion of scales, and so on, with a useful glossary of meteorological terms, and many other features, including as frontispiece the set of "cloud forms" with names and approximate altitudes (from Inwards' "Weather Lore"), and as tail-piece Dr. Jenner's well-known "Prognostics for Rain."

The Birds of Hampshire and the Isle of Wight, by the Rev. J. E. Kelsall, M.A., and Philip W. Munn (London: Witherby and Co., 1905).—County histories of this kind do not, as a rule, form very interesting reading, while their usefulness is extremely limited. The present volume is, however, a notable exception to this rule; it may justly be claimed for it, indeed, that it is one of the best monographs of its kind that has yet appeared. And this because it contains something more than the mere record of species occurring, or extinct, within the limits of the county. On the contrary, its pages are richly stored with most interesting matter gleaned from the works of such celebrities as Gilbert

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White, Col. Hawker, and Charles Kingsley; while the observations of others of the older but less famous residents in the county are often no less interesting. This is, notably, the case with the records which have been selected by the authors from the published works of Sir Richard Worsley, W. Gilpin, and J. R. Wise. We had imagined that nothing new of Gilbert White's now remained for publication, but this is not so, for the authors have succeeded in adding to this volume a certain amount of hitherto unpublished matter from MS. in the British Museum. The writers have included particulars of some 294 species, omitting such as are of doubtful occurrence, or have been introduced. Another feature of this book is the beauty of the illustrations, which have either been drawn by Mr. E. E. Lodge, or are reproduced from photographs; while the printing, paper, and binding show that the publisher is jealous of his reputation.—W. P. P.

Cloud Studies, by Arthur W. Clayden (J. Murray, 12s. net).—The study of cloud forms is certainly a most important subject, since it enables us to gain some idea of the meteorological conditions of the upper atmosphere, otherwise very difficult to obtain. Meteorologists are apt to rely almost entirely on the condition of the air within a very few feet of the ground, and to ignore that vast space of many miles high above our heads. Yet it is in the latter regions that rain and snow are formed, that the main winds prevail, often differing in strength and direction to those undercurrents close to earth, and that temperatures may vary and precede changes on the ground level. By carefully observing the shapes and distribution of clouds much may be learnt of their conditions. The author of this book takes pains to classify cloud-shapes by the various names, and asks, "Is it not time that the international names were regarded as those of cloud genera, and to add specific names for those varieties which seem to imply some difference in kind?" It may be so, although it seems to us that clouds cannot be classified the same as beetles or orchids. There are too many cross-breeds, and entirely new species would often be observed, but never to occur again. Altitude is probably one of the principal factors in the variable appearance of clouds, and this, as the author points out, involves a complicated and difficult process of observation. The book is profusely illustrated with very good reproductions of photographs of clouds.

Marine Boilers. Based on the work by L. E. Bertin, translated and edited by Leslie S. Robertson. Second edition (John Murray, 21s. net).—The first edition of this important work, by the Director of Naval Construction to the French Navy, was issued in 1898, since which time much progress has been made. The most notable additions to the present volume are a chapter on Liquid Fuel, by Engineer-Lieutenant H. C. Austey, and the reports of the Admiralty Committee on Types of Boilers issued in 1900 and 1904.

Some Elements of the Universe, Hitherto Unexplained. Part II., by A. Balding. (King, Sell, and Olding, Ltd., pp. 32, 1s. 6d. net).—Notwithstanding our unfavourable reception of Part I., the author sends us Part II., with an intimation that eight more parts are contemplated. Part I. was at least amusing, though perhaps unintentionally so. Part II. is almost entirely devoid even of this saving grace, consisting in great measure of scores and scores of diagrams illustrating the progressive motion of the moon's apside through a whole revolution. The effect is wearisome, and is not lightened by the harshness of the description. It is of course possible to find the L.C.M. of large numbers by trial, or to compute logarithms for oneself. We prefer the ordinary method, and even Mr. Balding does not venture to apply his alleged "discovery" to the correction of the moon's admittedly defective ephemeris, but simply gets his "computed places" from the Nautical Almanac. It would have been braver and more consistent to have gone further into the future. As to the alleged "discovery" to which we have before referred in connection with Part I., we wonder if Mr. Balding really imagines that when he is travelling the hands of his watch actually describe ellipses instead of circles. We would remind him that guarded abuse and thinly veiled sneers at the alleged short-comings of Newton and Laplace, as compared with Balding, are not argument, and that even if his notions were less obviously faulty, his attitude, which is not uncommon, tends to prejudice his case in the eyes of thinking men, who are inclined to ignore even strong arguments when presented with such questionable taste.

Last Words on Evolution, by Ernst Haeckel, translated by J. McCabe (London: A. Owen and Co., 1906, pp. 127, may be hoped most of us—do not accept Prof. Haeckel's illustrated; price 6s. net).—Although many of us — it views on evolution and religion in their entirety, it is satisfactory to have a well-written and concise expression of these views in what we are told is to be their final form. In the preface the aged Professor states, indeed, that this will be his last address to the public; and in this respect it must have a special and in some degree a pathetic interest. For, however much we may differ from the more extreme portions of the author's views, none, we hope, will fail to admire a man who has been so true to his own opinions, and who has maintained them so consistently against all opposition, as has Prof. Haeckel. The present volume is practically a report of two lectures delivered by the author in Berlin in the spring of 1905, and contains a full summary of all his views on evolution. It is a pity that in some places the book is marred by careless editing, as on page 53, where we find the date of Lamarck's first work given as 1899. Würtzburg on one page and Würzburg on another is a second example of such carelessness.

The British Woodlice: A Monograph of the Terrestrial Isopod Crustacea Occurring in the British Isles. By W. M. Webb and C. Sillem. (London: Duckworth and Co., 1906, pp. x + 54, 15 plates. Price 6s. net).—Most of us who are not specialists on the subject (and these, we presume, must be few), will be surprised on taking up this beautifully turned-out little work, to learn what a number of species of woodlice and "pillmillepedes" are to be found in our islands. Up to the present time it appears that those desirous of making themselves acquainted with what is known with regard to British Woodlice, have had to consult a foreign work, and one which, by the way, is not easy of access. This is not as it should be, for if there is one thing British naturalists ought to insist upon, it is the publication of complete monographs of the whole of the British fauna. In having accomplished this work for the group in question, Messrs. Webb and Sillem deserve the sincere thanks of their fellow naturalists. Mr. Sillem, it appears, has drawn all the illustrations; and drawn them, too, in a manner it would be difficult to surpass.

Darwinism and the Problems of Life: A Study of Familiar Animal Life. By C. Guenther. Translated by J. McCabe. (London: A. Owen and Co., 1906, pp. 436. Price 12s. 6d. net).—That a book of this class should have, within a comparatively short period reached a third edition in its native country is, of itself, almost a sufficient reason why it should be translated into English. And when we come to consider matters more fully, there is ample reason for confirming this *primâ facie* view. As a matter of fact, there is no really trustworthy work on Darwinism—that is to say, natural selection—in this country, composed on thoroughly popular lines; and as Professor Guenther's book has been written for the express purpose of meeting such a want in Germany, there seems every reason to suppose that it has a place to fill in England. One feature we are especially glad to notice, to wit, the omission from the text of the names of authorities. Too many scientific books are hopelessly marred by the continual introduction of names of persons of whom the public know nothing, and for whom they care less. Of course, we do not agree with all Professor Guenther's views; but in the main he seems to have expressed himself fairly and judgmatically. We may also add a word of praise for the translator, although we rather wonder what animal he means by a "fitchet weasel"—maybe a polecat?

Experiences of a Naturalist in the Pacific, Between 1896 and 1899. Vol. II., Plant Dispersal. By H. B. Guppy (London: Macmillan and Co., Ltd., 1906, illustrated. Price 21s. net).—So long ago as 1884, when surgeon on board H.M.S. *Lark*, in the Solomon Islands (when he had the good fortune to discover the second largest species of frog known), the author took an active interest in the modes by

which islands and continents become stocked with their respective floras. And four years later, the same kind of investigation was continued on Keeling Atoll, and during a journey along the coast of Java. This, however, failed to satisfy his idea of thoroughness; and in consequence the years from 1890 to 1896 were largely devoted to a study of the constitution of the British flora from the standpoint of dispersal by water. But the completion of the work was accomplished during a second residence in the Pacific, from 1896 to 1899, when Dr. Guppy spent a large amount of time on Vansea Leva, in the Fiji group, the geology of which forms the subject of the predecessor to the present handsome volume. That the author is fully competent to discuss such a difficult subject as plant-dispersal, must accordingly be self-evident; and it is probable that he may be regarded as one of the greatest living authorities on this branch of botany. To follow his arguments is quite impossible within our limits; and it can only be mentioned that Dr. Guppy attaches prime importance to the buoyant character of seeds and fruits as a factor in plant-dispersal. So much so, indeed, is this the case, that if plants be divided into two groups, the one with buoyant, and the other with non-buoyant fruits or seeds, it will be found that nearly all the members of the former are concentrated near the coast. Insects, bats, and birds have, however, likewise had a large share in the dispersal of seeds. Although much of the work is necessarily technical, a large portion is very interesting reading; and the whole forms a mine of information on a fascinating subject.

Methodes de Calcul Graphique en usage a l'Observatoire Royal de Lisbonne. Par Frederico Oom (Lisbon Imprimerie Nationale, 1905; pp. 25, with four plates).—The Observatory of Lisbon is to be congratulated on the success with which it has facilitated a number of different calculations by the use of diagrams, and by the construction of special forms of slide rules. We are told that the methods here described are all due in the first instance to Vice-Admiral Campos Rodrigues, the director of the Observatory. Among the calculations performed by diagrams, we note the corrections for deviation and level error in observations with a transit circle, corrections for temperature, calculations of precession. In all these calculations, the ordinary " graphs " of our school courses would be insufficient, as the quantities involve several variables; the methods are, in fact, more analogous to those described by M. d'Ocagne, under the title of Nomography. The slide rules are still more interesting. One is used for conversion of solar into sidereal time, and conversely; another, in which the graduations represent reciprocals instead of logarithms (as on the ordinary scale), serves for calculations such as those connected with conjugate foci of a lens; another, graduated in squares, serves to find the sum of several squares, a calculation frequently required in the theory of errors, and so on.

On Models of Cubic Surfaces. By W. H. Blythe, M.A. (Cambridge University Press, 1905; pp. 106).—Starting from the well-known property that a cubic surface has twenty-seven straight lines, real or imaginary, lying wholly on it, Mr. Blythe started some time ago to construct models of surfaces having these lines real. Finding, however, that such models had also been " made in Germany," the author has now collected in a handy form such properties and methods as are useful in obtaining information as to the forms and properties of cubic surfaces. There is no more fascinating study than the forms and classification of curves and surfaces, and the object of the investigations described in this book is to do for surfaces of the third degree what Newton did for curves of the third degree. But the most noteworthy feature of the book is that it can be read by anyone possessing a very limited knowledge of mathematics, and it can therefore be recommended for the interest of the subject to many readers for whom the majority of treatises on higher geometry are sealed books.

The Breeding Industry: Its Value to the Country, and its Needs. By W. Heape (Cambridge University Press, 1906; pp. xii + 154. Price 2s. 6d. net).—For many years past Mr. Walter Heape has devoted himself with unremitting attention and energy to the study of all matters connected with the breeding of domesticated animals, and the many problems to which such a study must inevitably lead. His life's experience must be of the utmost value to breeders, and it is therefore highly satisfactory to have the results of his studies published in a concise form, and at a price which will make them easily accessible to all. That there was need for such a work cannot apparently be denied, for we are told that, despite the pre-eminence of this country in cattle and horse breeding, science has never yet taken her proper place in connection with breeding, if, indeed, she can be said to have had a status of any kind. Indeed, the author goes so far as to say that the breeding industry is the greatest industry to which scientific principles have never yet been applied, and that the nation which first applies science in this manner will reap solid advantage. May it be hoped that Mr. Heape's book will bring England first into the field in this new departure.

The Citizen: A study of the Individual and the Government. By Nathaniel Southgate Shaler (London: Constable and Co., 1905).—This book, by N. S. Shaler, Professor of Geology in Harvard University, is written with the very laudable object of impressing on his readers, and especially Americans, the duty of taking an active part in the municipal and general government of their country. He commences by tracing the origin of mankind, and, as we would expect from a professor of geology who accepts the Darwinian hypothesis, the author goes on to trace the beginnings of government and then discusses the idea of liberty and the limits of freedom, the duties of citizenship, wealth, education, and civic government, religion, and the negro question. We consider the chapter on wealth contains sound advice to those who are inclined to extreme socialistic measures. On one point we would join issue with him. As regards the proposal to have a bodyguard to the President, he says, " It would establish a new principle that our magistrates are to be set apart from our people, and are not fellow citizens, to whom certain duties are for a time delegated. . . . Their risk is no greater than that of soldiers in time of war." We think that the position of President is more to be compared to that of a general, who does not needlessly expose himself to risk, as if he fall a campaign may miscarry. And as regards magistrates being set apart from the people, is not this necessary if the people are to respect the magistrates? We know the old proverb of familiarity breeding contempt, and there is no doubt that there is less respect for the courts of justice in America than in any civilised country.

MESSRS. JOHN WHELDON & CO.'s special catalogue of books and papers on Gardening and Horticulture has just been published, and is of great interest and value to botanists and horticulturists. The catalogue is especially strong in antique books on floriculture, and includes examples of the great Dutch horticulturist's works.

IN the new catalogues issued by Messrs. Isenthal and Co. the new mercury vapour lamps hold a prominent place. During the last few years the mercury vapour lamp, representing a much higher efficiency in the conversion of energy into light than is possible in the case of incandescent lamps or even of arc lamps, has passed out of the stage of a laboratory experiment into practical use. Messrs. Isenthal are now making them in three standard lengths of eighteen, twenty-six, and thirty-eight inches respectively, so as fully to utilise the varying standard voltages of from 100 to 250 volts. As the readers of " KNOWLEDGE " are well aware, the light from mercury vapour lamps is conspicuously free from red rays, and, being in appearance a bluish green light, imparts distinctive colours to all objects on which it falls. But it fatigues the eye very little, and, owing to the great diffusion of the rays arising from the length of the tubes in which the light glows, casts no hard shadows. It is, therefore, very useful for technical purposes, such, for example, as studio work, drawing, photochemical testing, or for therapeutic purposes. The richness of the light in ultra-violet rays lends to it specific purposes in other technical applications. Messrs. Isenthal include in their catalogue a number of new electric heating appliances to enable laboratories and factories to make use of the electric current for the purposes of chemical, metallurgical, and physical work to the fullest extent. These are often extremely ingenious, and show the increasing tendency to make use of electric energy for heating purposes.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 392.)

The details of adjustment and focussing may now be recapitulated. The necessary centring adjustments have been carefully explained, and the image may be assumed to be projected and focussed upon the ground-glass screen. It is well now to examine it carefully to see that it is correctly in the centre of the screen, and that its size corresponds with the plate to be used. If a quarter plate is being used it is well to mark the limits of the plate in pencil on the ground glass. Particular care should be taken at this stage to note if the illumination is even all over the field; if not, the sub-stage condenser may need a slight re-adjustment by means of its centring screws. It is also well to make now the final adjustments of the iris diaphragm of the sub-stage condenser, bearing always in mind that the apparent sharpening of the image by closing the diaphragm is more apparent than real, and that any excess in reduction of aperture will give fuzzy diffraction effects in the photograph as well as prolong the exposure and increase any tendency to unequal illumination. Of course, the lower the numerical aperture of the objective, the smaller will be the cone of illumination that it will bear, but it is a fairly safe general principle to shut down the diaphragm cautiously and to stop as soon as, or very soon after, the image begins to show signs of reduction in brightness. All these adjustments can only be carried out on the ground glass screen. The plain glass screen is then put in place of the ground glass, and the image is now invisible until the previously adjusted focussing lens is laid lightly upon the former screen; through this the eye looks directly down the tube, the focussing lens performing as a positive ocular. The increase in light is so marked that it will be difficult to make any other adjustments than those for the final focussing,and for this purpose the focussing lens is moved about on the glass whilst one hand adjusts the fine adjustment of the microscope. It is then only necessary to close the camera shutter gently, replace the plain glass screen with the dark slide, and make the exposure.

The extension of the camera gives considerable latitude in magnification independent of any change in objective or ocular, and, of course, with any change of objective the sub-stage condenser will generally need re-centring. But unless the camera is fairly short it will be found impossible to keep the eye at the focussing lens and at the same time to reach the fine adjustment. It is, therefore, more than a convenience to have a light rod running along the camera with a milled head at one end and at the other a grooved pulley lying exactly in line with the milled head of the fine adjustment of the microscope, which is now nearly always itself grooved for this purpose, whilst between the two an endless cord passes. The focussing adjustments can then be made with ease at the very end of a long camera extension. This arrangement is better than any Hooke's jointed rod. Messrs. Watson and Sons have, however, largely done away with the necessity for both ground and plain glass screens (as well as focussing rod), by inserting in their place a sheet of highly glazed cardboard, which can be viewed directly from the inside by means of a small door cut in the side of the camera. The facilities this gives for ease of adjustment of all the centring movements is great, and when I say that the flagella on a bacillus like *Typhosus* can be readily focussed by this means it will be seen that it is amply sufficient for nearly all purposes. I may, perhaps, mention that I myself use this method almost exclusively. But, of course, a good condenser and a strong light, such as the arc light or the oxy-hydrogen jet, are necessary, and for this reason I have gone into so much detail on the older and more general methods of focussing, &c.

(*To be concluded.*)

Royal Microscopical Society.

At the meeting held on February 21, the President, Dr. D. H. Scott, F.R.S., in the chair, Mr. Waldron Griffiths described his method for mounting delicate vegetable tissues in xylol-balsam, and exhibited under microscopes some excellent specimens of *Peziza*, *Spirogyra* in conjugation, and *Zygnema*. Mr. Beck exhibited and described an optical bench for microscope illumination, with ordinary or monochromatic light. Dr. Hebb exhibited a one-fifth inch objective, designed by Wenham in 1870, and made by Ross, to be used either as a dry or water-immersion lens. Mr. Walter Rosenhain described a new form of metallurgical microscope, the body of which is attached rigidly to a specially-designed limb carried on large trunnions, the stage moving up and down as is usual in metallurgical microscopes, and being provided with coarse and fine adjustments. Mr. Earland gave an abstract of a paper by Mr. W. P. Dollman on "A method of producing stereo-photomicrographs," and exhibited a number of exceedingly good stereoscopic prints in illustration of the paper. Mr. Taverner then read a short paper on "A simple method of taking stereo-photomicrographs, and of mounting the prints without cutting." The methods described in the two papers were quite different, and Mr. Dollman limits his operations to very low powers, giving amplifications of 9 to 20 diameters only. He uses a stop in front of the objective and exposes first one side of the lens and then the other, as he takes his two stereoscopic photographs. Mr Taverner uses higher powers, and a peculiar stop at the back of the objective. The authors adopt a similar arrangement for obviating the necessity of cutting the prints. Mr. Rousselet gave an abstract of a paper from the Hon. T. Kirkman, "A second list of Rotifers of Natal," in which a remarkable new species, *Copeus triangulatus*, was described.

Quekett Microscopical Club.

At the annual general meeting held on February 16, the President, Dr. E. J. Spitta in the chair, the annual report showed an increase in membership during the year, the number of members on December 31, 1905, being 402. The hon. treasurer's report on the financial state of the Club was also very satisfactory. Dr. E. J. Spitta, F.R.A.S., F.R.M.S., was re-elected president, all the other officers were also re-elected, with the exception that Dr. G. C. Karop becomes a vice-president in place of the late Mr. J. G. Waller. The president delivered the annual address, dealing with "The Relative Merits of the Short and Long Tube for Microscopes." The short-tube stand was probably intro-

duced by Oberhäuser, certainly before 1857. It was not received with favour in this country as it was considered that too much work had to be done by the ocular in comparison with that required in the English form, that is, to obtain the same amplification. Consequent on the great improvements by Abbe in the construction of objectives, this objection cannot now be sustained, as a modern objective should stand such magnification by the ocular as will bring the total amplification up to one thousand times the N.A., without furnishing a "rotten" image. For ease of observation when the instrument is placed in a vertical position, as, for instance, when using fluid media on the stage, the advantage of the short-tube form is indisputable. In photomicrography the long-tube has some advantages, but the ideal instrument was considered to be a short-tube stand, which could be quickly converted to the long form, either tube length being available as required.

Cinematograph and Microscopy.

At a recent meeting of the Society of Arts, Mr. F. M. Duncan showed examples of the successful application of the cinematograph to microscopical investigation, illustrating the circulation and rotation of protoplasm, and the movement of the chlorophyll bodies within the cells of the leaf of *Elodea*; the circulation of the blood in the web of the frog's foot and in the tail of the gold-fish. The lecturer also exhibited micro-bioscope pictures of *Hydra Viridis*, various birds, beasts, and reptiles in motion, and of the life and work of the wood ant.

Notes and Queries.

S. C. Mitra, Bombay.—The samples of wood sent you contain various woods, but you will find drawings in Hertzberg's book which will enable you to judge of this for yourself. The colours of the wood-pulps mean merely that one is treated so as to be of a whiter colour for paper-making and to need less bleaching. Some wood fibres polarize very well, others not at all—it is largely a matter of treatment in manufacture. A thin slice of raw deal, for instance, polarizes excellently. Polarized light often brings the structure out better, but not always—it is of course a question of refraction.

C. E. Garner, Shanghai.—I was glad to get your letter and wish you all success with your work. It must be very difficult to work so far from home, but I shall be very glad to help you in any way I can. You certainly have a good outfit and no lack of books of reference. You cannot do better than continue your entomological studies, and I should be most grateful for any insects you can send me, many of which would very probably be welcome in the University Museum here. The mere collecting of insects from your district for transmission home would be of much interest and use, with such additional study as you could give them. Do you ever get any mites? I know at least two people here to whom they would be of great interest.

W. H. M., Tunbridge Wells.—The best monochromatic light is undoubtedly obtained with a prism and heliostat, but this has such palpable disadvantages that it is seldom used. The prism has recently been adapted for use with a Nernst electric lamp, and this gives very good results, but with any less powerful means of illumination the loss of light is too great. For all ordinary purposes, Mr. Gifford's new fluid screen fulfils every requirement. It consists of a slip of signal green glass immersed in a solution of malachite green in glycerine, and gives practically monochromatic light, though even here there is a marked loss of light when using immersion lenses. Mr. Gifford's simple little F line screen, which drops into the condenser mount is cheap and handy, but less perfect, and loses more light still. I have found the fluid screen fulfil every requirement.

"Arabian," Jerusalem.—I do not consider that there is any difference in workmanship in the two microscopes you mention, in spite of the difference in price. You are, however, quite right in your criticisms as to the Continental form of fine adjustment, and though makers who used this adjustment for a long time argued stoutly that it was not unsatisfactory, they have now admitted it by fitting improved adjustments to their more expensive stands, such as you mention. These adjustments are a great improvement, but they are expensive. My advice would certainly be to have this improved fine adjustment if you have definitely decided to buy a Continental stand, but an English stand, if carefully selected, would be equally satisfactory in every way and would, contrary to the common idea, cost you less. Between the two immersion lenses you mention there is, in my opinion, nothing to choose. Both are excellent.

R. S. B. P., Streatham.—Mr. Cole's method of mounting pollen is, after drying it, to soak it for some days in turpentine, and then to mount the cover-glass in a drop or two of Canada balsam, spreading the grains evenly with a needle, and then putting away to dry. When dry, it is only necessary to add another drop or two of balsam, and to mount on a warm slide in the usual way. By this means the pollen is prevented from running together in the centre of the slide. Pollen makes beautiful opaque mounts. Pollens can be stained readily by any of the aniline dyes, such as methyl blue or green. They must be first soaked in methylated spirit to remove air and colour, then dyed in a strong alcoholic solution of the stain for an hour or two; the stain poured off, rinsed in spirit, this poured away and clove oil added; this again poured away, and mounting in Canada balsam proceeded with as above. Very pretty slides can be made by staining equal quantities of the pollen different colours and mixing them together just before mounting in the Canada balsam. Gentian violet and Vesuvin are bacterial stains, and the former is also used as a general nuclear stain.

A. G., Chorlton-cum-Hardy.—It is not very easy to answer your questions. The amount of mathematics required "to study light" depends upon how far you wish to go in your study, and I should scarcely advise a man to study the subject from its mathematical side who had not a good preliminary grounding in algebra, geometry, and trigonometry, as a basis. Perhaps the best book on algebra for a home student would be Hall and Knight's "Elementary Algebra," and it would be necessary to know practically the whole of this book as well as such an elementary book on Trigonometry as Lock's. In the same way it is not easy to say how much Euclid is necessary. What is really necessary is a sound preliminary mathematical training, and for this the whole of Euclid cannot be considered too much. On the other hand, if you merely wish to understand and follow such simple mathematical expressions as would be found, for instance, in Glazebrook's "Light," I suppose a knowledge of algebraical addition, subtraction, multiplication, and division, and of simple equations, would serve your purpose.

S. P. M., London.—I am sorry your questions have remained so long unanswered, but it has been due to the necessity of getting your specimens named, for which I am indebted to the kindness of Mr. E. R. Burdon, the Curator of the Botanical Museum in the University of Cambridge. He says: "The bright reddish-pink cushions on a bit of bark are fructifications of Nectria; the waxy darker coloured pustules on a bit of wood are Dacryomyces; the brown pustules on birch bark are some species of Hypoxylon. All these are fungi. The withered piece of a fruit had two oblong brown bodies, which have got knocked off, but I think they were cocoons or eggs of some insect. The circular patches on the back of a bit of a fern frond are groups ('sori') of sporangia of the fern Aspidium. I am afraid there is no book of a popular nature on the smaller fungi (other than Cooke's). The only way to identify such fungi is to cut sections and see the nature of the fructifications and size and colour of the spores—and then, in most cases, ask an expert."

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for April.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.39 and sets at 6.30; on the 30th he rises at 4.37 and sets at 7.18. The equation of time is negligible on 16th, hence this is a convenient date for the adjustment of sundials.

Sunspots and faculæ are usually conspicuous on the solar disc, whilst recent spectroscopic observations of the limb have shown many prominences.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
April 1 ..	26° 22′ W	6° 28′	169° 56′
,, 6 ..	26° 30′ W	6° 9′	103° 56′
,, 11 ..	26° 27′ W	5° 49′	37° 57′
,, 16 ..	26° 13′ W	5° 25′	331° 57′
,, 21 ..	25° 50′ W	4° 59′	265° 55′
,, 26 ..	25° 14′ W	4° 31′	199° 51′

THE MOON:—

Date.	Phases.	H. M.
April 2 ..	☽ First Quarter	4 2 a.m.
,, 9 ..	○ Full Moon	6 12 a.m.
,, 15 ..	☾ Last Quarter	8 37 a.m.
,, 23 ..	● New Moon	4 7 p.m.
,, 10 ..	Perigee	9 24 a.m.
,, 25 ..	Apogee	0 54 p.m.

OCCULTATIONS.—The following are the occultations of the brighter stars visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.			Reappearance.		
			Mean Time.	Angle from N. point.	Angle from Vertex.	Mean Time	Angle from N. point.	Angle from Vertex.
			p.m.			p.m.		
April 4	π^2 Cancri	5·6	6.37	119°	143°	7.52	271°	279°
,, 5	REGULUS ..	1·3	5.48	67°	102°	6.42	327°	356°
,, 6	χ Leonis	4·7	7.3	149°	181°	7.57	253°	277°
,, 11	49 Librae	5·6	10.56	165°	197°	11.30	233°	261°
,, 27	119 Tauri	4·6	8.51	83°	42°	9.48	276°	238°
,, 27	120 Tauri	5·3	9.28	95°	56°	10.24	263°	227°
,, 30	ζ Cancri	4·7	11.33	110°	70°	12.28	274°	236°

THE PLANETS.—Mercury (April 1, R.A. $0^h\ 58^m$; Dec. N. 9° 42′. April 30, R.A. $0^h\ 51^m$; Dec. N. 2° 32′) is in inferior conjunction with the Sun on the 5th and hence unobservable at the beginning of the month; towards the end of the month the planet is a morning star in Pisces.

Venus (April 1, R.A. $1^h\ 24^m$; Dec. N. 7° 51′. April 30, R.A. $3^h\ 43^m$; Dec. N. 19° 57′) is an evening star in Aries, setting about an hour after the Sun on the 1st and about two hours after on the 30th. The apparent diameter of the planet is 10″·6, and 0·97 of the disc appears illuminated.

Mars (April 1, R.A. $2^h\ 33^m$; Dec. N. 15° 18′. April 30, R.A. $3^h\ 56^m$; Dec. N. 20° 56′) is an evening star in Taurus, setting about 9.25 p.m. throughout the month. The planet may be observed shortly after sunset looking a little north of west, but he does not appear very bright, as he is at a point in his orbit situated at a great distance from the earth.

Jupiter (April 1, R.A. $4^h\ 7^m$; Dec. N. 20° 22′; April 30, R.A. $4^h\ 32^m$; Dec. N. 21° 26′) is getting more to the west, and is only available for observations for a few hours each evening; about the middle of the month the planet sets about 10.45 p.m.

The equatorial diameter of the planet on the 14th is 34″·6, whilst the polar diameter is 2″·2 smaller.

The following table gives the satellite phenomena observable in this country:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Apr				Apr				Apr			
4	I.	Oc. D.	7 54	12	I.	Sh. I.	7 59	24	III.	Tr. I.	8 22
5	I.	Sh. E.	8 18		I.	Tr. E.	9 17	25	II.	Sh. E.	8 21
6	III.	Oc. D.	9 16	19	I.	Tr. I.	9 4	27	I.	Oc. D.	8 27
7	II.	Tr. I.	9 10	20	I.	Ec. R.	9 26	28	I.	Sh. E.	8 32
9	II.	Ec. R.	7 55	23	II.	Oc. D.	8 57				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (April 1, R.A. $22^h\ 47^m$; Dec. S. 9° 26′. April 30, R.A. $22^h\ 58^m$; Dec. S. 8° 25′) is a morning star in Aquarius, rising about 4 a.m. near the middle of the month.

Uranus (April 15, R.A. $18^h\ 37^m$; Dec. S. 23° 28′) does not rise until after midnight; he is situated low down in Sagittarius.

Neptune (April 15, R.A. $6^h\ 34^m$; Dec. N. 22° 19′) is on the meridian before sunset, but is observable in the west until midnight; near the middle of the month the planet sets about 1 a.m.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
Apr. 17-May 1	16 0	+47°	τ Herculids	Small; short.
,, 20-21 ..	17 24	+36°	π Herculids	Swift; bl. white.
,, 20-22 ..	18 4	+33°	**Lyrid Shower**	Swift.
,, 30 ..	19 24	+59°	o Draconids	Rather slow.

Minima of Algol may be observed on the 11th at 11.33 p.m., and on the 14th at 8.22 p.m.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—γ Virginis, XII.^{h} 37^m, S. 0° 54′, mags. 3, 3; separation 5″·9. Binary system; both components are yellow, though one is of a deeper hue than the other. An eyepiece of a power of 30 or 40 is required on a 3-in. to effect separation.

π Boötis, XIV.^{h} 36^m, N. 16° 53′, mags. 4, 6; separation 6″. Requires a power of about 40.

ϵ Boötis, XIV.^{h} 41^m, N. 27° 30′, mags. 3, 6½; separation 2″·6. Very pretty double, with good colour contrast, the brighter component being yellow, the other blue green.

ξ Boötis, XIV.^{h} 47^m, N. 19° 31′, mags. 5, 7; separation, 2″·4. Binary; one component being orange, the other purple.

CLUSTERS.—M 3 *(Canes Venatici)*, XIII.^{h} 38^m, N. 28° 48′. This object, though really a globular cluster of myriads of small stars, appears more like a nebula in small telescopes. It is situated between Cor Caroli and Arcturus, but rather nearer the latter.